

FISH

SALMON, STEELHEAD, CLAMS, oysters, crab, shrimp – these and other finfish and shellfish are an integral part of the history and culture of the Pacific Northwest. Today, as in centuries past, they play an important role in the economy, recreation and cultural identity of Washingtonians and the entire Pacific region. Fish are also a natural wonder in their own right, serving as a barometer of the general health of the state's aquatic environment.

Commercial fishers harvested nearly 200 million pounds of marine finfish and shellfish during the last two years, supporting thousands of jobs in processing, wholesaling and retailing. The price paid to tribal and non-tribal fishers for that catch – prior to processing or distribution – was approximately \$170 million. Recreational fishers took far fewer fish, but generated significantly more in retail sales on fishing trips and gear throughout the state. According to a study recently published by the National Marine Fisheries Service, saltwater anglers in Washington state spent well over \$1 billion on fishing trips (e.g. boat rentals, motel accommodations, meals, etc.) in 2000 alone.¹ All these fishing activities make a significant contribution to the state's economy and help to sustain many communities – both urban and rural – on Puget Sound, the Pacific coast and the Columbia River.

Many finfish and shellfish fisheries are jointly managed by the Washington Department of Fish and Wildlife (WDFW) and Washington treaty tribes, which have a legally established right to catch up to 50% of the allowable harvest within their usual and customary fishing areas. In the 1999-01 Biennium, as in previous years, WDFW worked closely with tribal fisheries managers to establish harvest plans consistent with joint conservation goals for salmon, steelhead, Dungeness crab, shrimp and other marine fish. WDFW's legislative mandate in managing all marine and freshwater species is to “preserve, protect and perpetuate” fish populations and at the same time to “enhance and improve recreational and commercial fishing in this state.”

Meeting these diverse goals always presents a challenge, but never more so than after the 1999 listing



A WDFW diver has a close encounter with a smallmouth bass in Lake Washington.

of an additional seven salmonid population groupings under the federal Endangered Species Act (ESA) brought a new urgency to salmon management. Other species, from Dungeness crab to zebra mussels, brought challenges of their own. Actions taken by WDFW and the Washington Fish and Wildlife Commission to address these challenges are discussed in this section of the report, along with the status of game and non-game species, hatchery production and annual landings. Key developments in four management areas are summarized below.

- **Salmon:** With new ESA listings as a backdrop, state and tribal co-managers gained federal approval for fishery management plans designed to protect depressed populations while providing fishing opportunities focused on abundant hatchery and wild stocks. Selective salmon fisheries were greatly expanded, requiring anglers to release salmon not visibly marked as hatchery fish in many areas. State hatcheries released somewhat fewer juvenile salmon than in recent years, but salmon recovery programs at some facilities saw record

¹ The study by the National Marine Fisheries Service (NMFS) estimated that saltwater fishers spent from \$1.2 billion to \$1.6 billion on fishing trips in Washington state in 2000. A previous study issued by the U.S. Fish and Wildlife Service estimated that anglers spent \$710 million on fishing trips in Washington in 1996. The variation in these estimates appears to be due to differences in methodology, rather than major changes in fishing or spending patterns.

Landings by Commercial Fisheries in Washington*

Species	1999		2000	
	Lbs.	Est. Value	Lbs.	Est. Value
SALMONIDS				
Chinook	2,507,900	\$1,742,800	2,278,900	\$1,819,700
Chum	2,603,800	783,200	3,087,300	1,151,700
Pink	202,800	31,000	1,800	1,600
Coho	1,739,000	870,000	3,725,700	1,722,900
Sockeye	122,400	150,300	3,248,700	3,820,100
Steelhead	260,400	23,300	315,000	32,300
Salmon Eggs	71,400	295,500	115,200	825,400
Total Salmonids	7,507,700	\$3,896,100	12,772,600	\$9,373,700
MARINE FISH				
Sturgeon (White)	144,400	150,800	212,100	251,100
Sturgeon (Green)	16,700	5,900	57,200	19,800
Mixed Shad	96,400	9,700	78,700	9,900
Columbia River Smelt	10,600	27,500	9,900	25,500
Albacore Tuna	4,190,700	3,313,400	6,724,100	5,556,600
Herring	774,700	204,300	532,800	208,400
Anchovy	215,600	66,300	173,400	47,700
Sardines	3,000	1,600	10,674,500	519,400
Silver Smelt	136,200	62,200	143,600	62,100
Pacific Halibut	3,092,500	7,715,200	2,325,300	6,365,100
Sole (General)	24,900	8,500	39,000	12,400
Sole (Dover)	1,770,500	577,000	1,673,900	579,600
Sole (English)	893,900	282,200	1,320,200	408,600
Sole (Petrale)	566,800	545,900	873,700	880,500
Sole (Rex)	48,600	16,500	83,900	29,400
Sole (Rock)	17,100	5,700	32,400	11,000
Sole (Sand)	21,400	14,000	11,800	8,400
Starry Flounder	185,400	40,300	190,900	35,500
Arrowtooth Flounder	6,539,100	625,000	4,594,000	501,600
Sablefish	4,088,000	4,748,500	3,756,600	5,318,300
Lingcod	109,900	60,900	69,000	41,900
Pacific Cod	628,000	265,500	816,900	372,600
Pacific Whiting	20,139,000	752,500	26,799,700	1,022,300
Rockfish	1,004,800	472,200	423,028	204,442
Rockfish (Canary, Red)	262,600	101,800	21,900	10,000
Rockfish (Widow, Brown)	1,130,800	424,000	825,100	360,200
Rockfish (Yellowtail, Green)	1,241,500	444,000	1,891,500	827,400
Pacific Ocean Perch	339,300	129,100	178,500	66,400
Long Spine Thornyhead	70,000	46,200	41,500	32,000
Short Spine Thornyhead	133,300	101,600	103,400	84,800
Pile Perch	23,200	14,200	16,100	11,800
Shark (General)	13,300	1,900	700	200
Spiny Dogfish	1,129,900	166,200	1,428,100	237,100
Thresher Shark	144,300	127,400	98,500	101,600
Skate	369,000	33,900	686,700	47,800
Misc Marine Fish Total	382,700	35,500	106,700	14,400
Total Marine Fish	49,958,100	\$21,597,400	67,015,328	\$24,285,842
SHELLFISH				
Geoduck Clams	4,236,200	16,484,500	3,448,900	15,254,600
Native Littleneck Clams	87,200	62,600	62,500	47,300
Razor Clams	0	0	69,600	84,100
Manila Clams	761,900	1,111,000	684,400	1,023,800
Pacific Oyster	98,800	243,800	93,300	268,500
Octopus	3,400	2,100	2,500	1,500
Dungeness Crab	19,025,800	37,447,800	17,758,900	36,306,500
Coon Stripe Shrimp	68,400	66,700	76,000	73,300
Spots Shrimp	252,700	1,078,700	278,400	1,434,200
Side Stripe Shrimp	16,400	12,200	13,000	9,900
Pink Shrimp	3,746,200	1,610,400	5,061,100	1,950,300
Sand or Ghost Shrimp	95,300	114,900	107,700	143,000
Crawfish (General)	8,300	14,100	7,200	12,700
Sea Cucumbers	504,400	585,000	605,800	836,700
Red Sea Urchin	342,600	344,900	658,200	504,300
Green Sea Urchin	272,300	261,500	280,800	276,600
Misc Shellfish Total	3,800	2,800	900	800
Total Shellfish	29,523,700	\$59,443,000	29,209,200	\$58,228,100
GRAND TOTAL	86,989,500	\$84,936,500	108,997,128	\$91,887,642

* Includes treaty fisheries and some fish caught outside Washington waters. Excludes imports, aquaculture and invoices.

adult returns in 2001. The 1999 salmon harvest was the lowest on record, but fishing improved significantly in 2000 in most areas and showed even greater promise in 2001, a year that began with a record return of spring chinook to the Columbia River and a strong run of coho off the coast.

- **Freshwater fish:** The Department increased the number of catchable-size trout planted in low-land lakes from 2.3 million in 1999 to 3 million in 2001, and the introduction of large “triploid” trout proved to be especially popular with anglers. With funding provided by the state Legislature The Meseberg Warmwater Fish Hatchery became fully operational and WDFW significantly expanded its youth sport fishing program. Bull trout and naturally spawning steelhead populations in the mid-Columbia River were listed under the ESA in 1999, and WDFW worked throughout the biennium with tribal, federal and local management entities to facilitate their recovery.
- **Shellfish:** Responding to growing fishing pressure on a number of key species, WDFW and the Washington Fish and Wildlife Commission took action to protect the resource and ensure orderly fisheries. The first harvest quotas were established for Dungeness crab in Puget Sound, and pot limits were instituted for commercial fisheries on the coast. Recreational crabbers were also required, for the first time, to record their catch on a catch record card to facilitate better monitoring of the catch. The Puget Sound commercial shrimp fishery was converted to limited entry status in 2000, and the Commission established daily bag limits for previously unregulated species such as shore crabs, marine snails and sea slugs. A major investigation by the WDFW Special Investigations Unit into the geoduck clam industry resulted in charges against a Canadian fish buyer and new commitments by state and tribal fisheries co-managers to monitor the harvest more closely.
- **Marine fish:** The Fish and Wildlife Commission banned bottom trawling within three miles of the Washington coast to provide additional protection for black rockfish, flat fishes and immature marine fish. In Puget Sound, the bag limit for rockfish was reduced to one fish per day and two new no-fishing marine reserves were established to serve as “natural hatcheries” for groundfish populations. At the same time, the

Commission opened the first commercial sardine fishery in nearly 50 years after surveys revealed steady growth in sardine populations off the Washington coast.

In all of these decisions, WDFW and the Commission relied on the best available science to strike a balance between the agency’s dual mandate to protect the resource and to improve recreational and commercial fishing in this state. In the case of salmon fisheries, new mass-marking techniques, coded wire implants, otolith markings and other scientific innovations provided the Department with the information needed to direct fisheries toward abundant stocks while protecting those in decline. Research on new types of fishing gear showed promising results for making commercial salmon fisheries more selective. For Puget Sound crab fisheries, seasons were restructured in 2000 when field studies revealed that the molting season, when crab are in a vulner-



A WDFW shellfish biologist collects oyster samples in the tideflats of Willapa Bay.

able, soft-shelled condition, varies considerably from area to area. In these and other areas, science set the course for fisheries management by WDFW and the commission.

The WDFW Fish Program is responsible for preserving and perpetuating all game fish, food fish, shellfish, unclassified marine aquatic species, aquatic pests and for managing all fish culture activities for the agency. The program is organized into four divisions: Hatcheries, Fish Management, Science and Administrative Operations. The largest of the five programs within WDFW, the Fish Program had an operating budget of \$113.1 million in the 1999-01 Biennium, supporting the work of 787 FTEs. Program managers coordinated the work of staff located at the agency's Olympia headquarters and at six WDFW regional offices throughout the state.

Fish Program Funding and Personnel, 1999-01 Biennium

(dollars in thousands)		GF-S		OTHER FUNDS		TOTAL	
Division	Funding	FTEs	Funding	FTEs	Funding	FTEs	
Administration	\$3,746	20	\$1,287	8	\$5,033	28	
Science	\$3,194	37	\$12,158	88	\$15,352	125	
Hatcheries	\$17,303	114	\$38,964	226	\$56,267	340	
Fish Management	\$13,078	110	\$23,332	184	\$36,410	294	
TOTAL	\$37,321	281	\$75,741	506	\$113,062	787	

Major support for the Fish Program's operations was provided by the WDFW Intergovernmental Resource Management Group, which took the lead in developing policies involving treaty tribes, other states and nations, and the federal government. The IRM worked closely with the Fish Program and a variety of other partners to implement salmon-recovery plans consistent with the ESA, develop co-manager harvest plans for finfish and shellfish, and address other intergovernmental issues. Fish Program staff also worked closely with the Habitat Program, both in policy development and in the field, to protect fish in their ocean environment and in watersheds throughout the state.

SALMON

WHEN LEWIS AND CLARK REACHED the confluence of the Columbia and Snake rivers in 1805, a member of their party wrote with astonishment of the "large quantities of sammon" [sic] being harvested by native people. Before and since that historic expedition, salmon have played an integral role in the commerce, recreation and cultural identity of the people of the Pacific Northwest. Salmon are an economic mainstay for coastal communities, a focal point for tribal life and an important food source for a broad range of birds, mammals and other fish.

For these and other reasons, salmon present one of the biggest management challenges of any fish or wildlife species in North America. Nearly 300 indigenous salmon populations and nearly 200 hatchery stocks return to Washington's waters every year, each with its own biological and legal requirements. Management of these fish is shared between WDFW and treaty tribes, which are legally entitled to catch up to 50% of all harvestable salmon in usual and

customary fishing areas. As in previous years, WDFW worked in conjunction with tribal fisheries managers to determine annual run sizes, establish harvest levels and develop management plans for this shared resource.

Looming over these and other management decisions was the 1999 listing of seven additional groupings of naturally spawning salmon and steelhead populations – including Puget Sound chinook – under the federal ESA. Although state and tribal co-managers had been working for years to protect and recover depressed wild runs, the new listings brought a new level of complexity to the job of managing salmon populations and fisheries. Under the ESA, the co-managers were required to seek federal approval for any activity – including fisheries, hatchery operations or research – that may affect even one member of a listed population. For hatcheries, alone, WDFW filed 128 Hatchery Genetic Management Plans with the National Marine Fisheries Service detailing the potential impacts of

specific programs on listed populations and laying out plans to minimize these impacts.

In these and other activities, WDFW worked to fulfill its legislative mandate to “preserve, protect and perpetuate” the resource while also maintaining the stability of the commercial fishing industry and maximizing recreational fishing opportunities for the general public. To meet these objectives, state and tribal co-managers carried out a number of new initiatives discussed in this and other sections of the report.

- Mass marking of hatchery salmon prepared the agency to implement selective fishing on a broad scale. Anglers could retain marked hatchery fish, but were required to release unmarked salmon in certain areas. (See section titled “Salmon Harvest.”)
- State hatcheries produced millions of fish for harvest, while continuing to restructure their operations to help recover wild salmon populations. Several recovery projects showed significant results in the 1999-01 Biennium. (See section titled “Hatcheries.”)
- WDFW played a key role in a statewide effort to restore salmon habitat by providing scientific and technical assistance to Lead Entities, Regional Fisheries Enhancement Groups (RFEs) and other local salmon-recovery organizations. (See section titled “Habitat.”)
- Research focused on new methods of marking and identifying salmon from various runs. New types of selective commercial fishing gear were tested that appear to significantly reduce the mortality of released salmon. (See section titled “Salmon Research.”)
- WDFW established a Marine Division to improve enforcement of new fishing regulations, including selective fishing rules. (See section titled “Enforcement.”)



A female chinook salmon is captured on the Green River as a step toward measuring spawning escapement.

The 1999 salmon fishing season marked the lowest statewide catch on record – due partly to new fishing restrictions, but mostly to poor freshwater and ocean conditions that resulted in meager returns. In 2000, landings increased substantially, reflecting improvements in environmental conditions that may mark the beginning of a new period of greater productivity.

Complete catch statistics for 2001 are not yet available, but runs of coho, pink and chum salmon were generally strong from Puget Sound to the Columbia River. In the spring of that year, a record run of upper Columbia spring chinook salmon yielded a catch of 26,000 fish, the largest harvest of that stock since 1973.

At WDFW, the Fish Program has an array of management responsibilities for salmon, involving staff in the divisions of Fish Management, Hatcheries and Fish Science. Fishing seasons, long-term management agreements and international treaties for salmon are negotiated by members of the Intergovernmental Resource Management, created by the WDFW director in 1999. The Department’s Enforcement and Habitat programs also play important roles in protecting and recovering salmon populations, as discussed in other sections of this report.

ESA LISTINGS and SALMON RECOVERY

In March 1999, the federal government listed naturally spawning salmon and steelhead populations in seven new areas under the Endangered Species Act (ESA), adding coastal/Puget Sound bull trout to the list in November of that year. The National Marine Fisheries Service (NMFS) also reviewed the status of seven marine fish species within Puget Sound during the 1999-01 Biennium, but none were determined to warrant ESA protection at that time. Georgia Basin Pacific hake remains a candidate species.

The March 1999 listings brought the total number of regions in Washington state where salmon and steelhead were protected under the ESA to 15, with others such as Lower Columbia/Southwest Washington coho and coastal cutthroat trout still pending. Although WDFW had been managing fisheries to protect listed stocks since 1991 when Snake River sockeye were listed as endangered, the new listings posed a major challenge for the state and tribal co-managers in the 1999-01 Biennium.

Under the ESA, federal authorization is required for any activity that might kill or injure (“take”) even one individual in a listed “evolutionarily significant unit” (ESU), a federal designation which can include a number of fish stocks in a specified



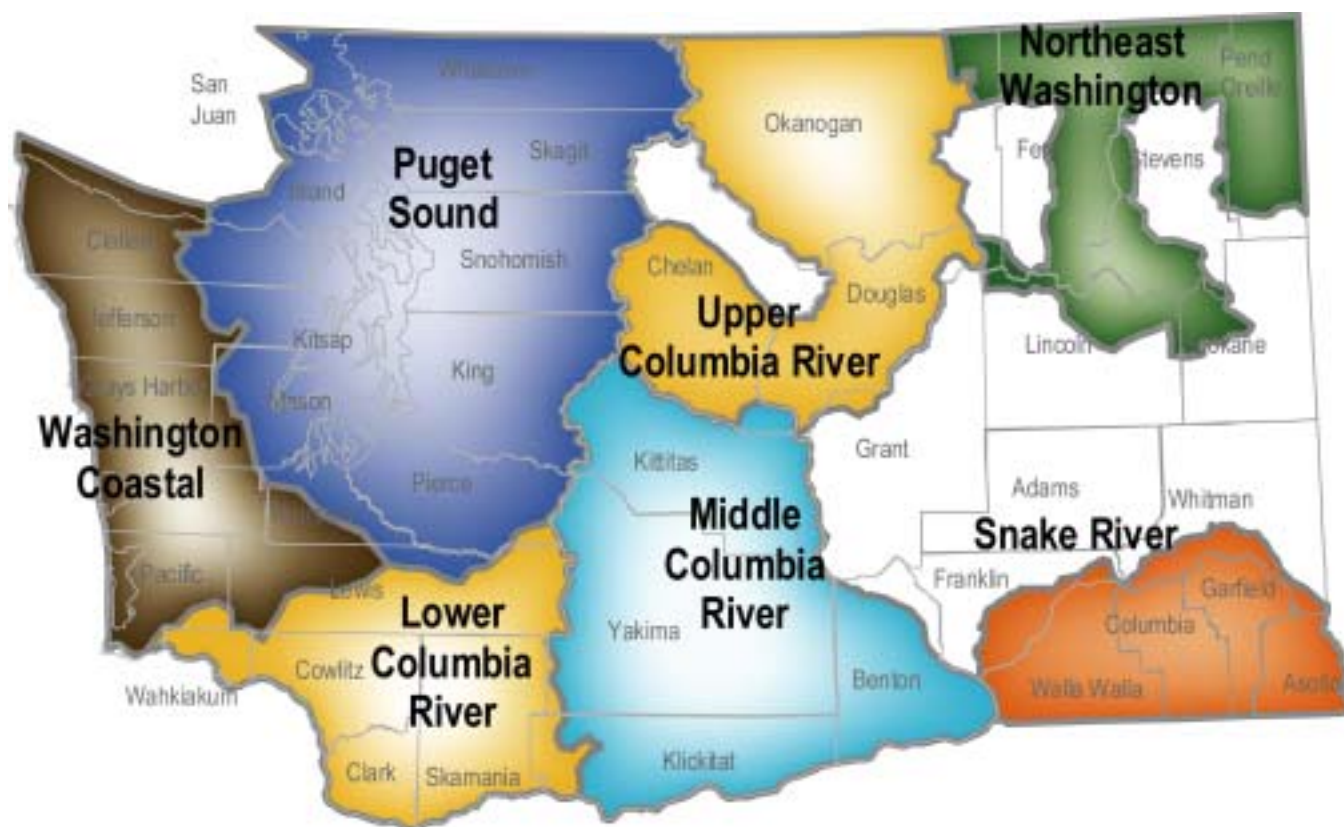
A naturally spawning steelhead takes to the air to clear a barrier at Kalama Falls.

geographical area. For state and tribal co-managers, that means demonstrating that any given fishery, hatchery operation or research activity – whether directed at healthy naturally spawning salmon, hatchery fish or other species – will not inhibit recovery of a listed population.

Nowhere was this challenge more apparent than in the Puget Sound region, where chinook salmon became the first anadromous species in the nation to be listed a major metropolitan area. Encompassing 17 major river systems, 33 state hatchery programs and multiple fisheries, the ESU for Puget Sound chinook salmon extends from the Nooksack River in Whatcom County south to the Deschutes River in Thurston County, including Hood Canal and the eastern part of the Strait of Juan de Fuca. On the Columbia River, new listings of chinook and chum salmon, as well as Mid-Columbia steelhead, left no major tributary without at least one stock listed under the ESA.

None of these listings came as a surprise to state and tribal co-managers, who had been working for nearly a decade to recover depressed stocks in these and other areas. Throughout the 1990s, fishing seasons were dramatically curtailed as co-managers imposed new time, area and gear restrictions to protect weak runs. Beginning in 1996, WDFW and some treaty tribes began mass-marking hatchery-produced salmon, setting the stage for today’s selective fisheries in which naturally spawning fish can be identified on sight and released. Hatchery operations have also been modified to reduce interactions with wild runs and a third of WDFW’s salmon hatchery programs have been redesigned specifically to facilitate their recovery.

Although “take” prohibitions did not go into effect for most of the new listings until September 2000 or later, state and tribal co-managers communicated with representatives of the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) throughout the biennium to determine how activities under state and tribal jurisdiction would have to be modified to comply with the ESA. While some changes in fisheries and hatchery practices were made to accommodate federal concerns in 2000 and 2001, most were an extension of efforts begun in previous years. As recovery plans progress, further changes to fisheries, hatcheries and habitat programs are expected.



Washington Salmonids and the ESA

Population groupings listed, proposed for listing, or candidates for listing as of December 2001

Chinook Salmon

- Puget Sound chinook listed as threatened 3/24/99
- Lower Columbia River chinook listed as threatened 3/24/99
- Upper Columbia River spring run chinook listed as endangered 3/24/99
- Snake River spring/summer chinook listed as threatened 4/22/92
- Snake River fall chinook listed as threatened 4/22/92

Chum Salmon

- Hood Canal/Strait of Juan de Fuca summer chum listed as threatened 3/25/99
- Columbia River chum listed as threatened 3/25/99

Sockeye Salmon

- Lake Ozette sockeye listed as threatened 3/25/99
- Snake River sockeye listed as endangered 11/20/91

Coho Salmon

- Puget Sound coho designated as candidate for listing
- Lower Columbia/SW Washington coho designated as candidate for listing

Steelhead

- Lower Columbia River steelhead listed as threatened 3/19/98
- Middle Columbia River steelhead listed as threatened 3/25/99
- Upper Columbia River steelhead listed as endangered 8/18/97
- Snake River steelhead listed as threatened 8/18/97

Bull Trout

- Coastal/Puget Sound bull trout listed as threatened 11/1/99
- Columbia River bull trout listed as threatened 6/10/98

Cutthroat Trout

- SW Washington/Columbia River coastal cutthroat proposed for listing as threatened 4/5/99

The Summer Chum Salmon Conservation Initiative

Co-managers develop comprehensive approach to salmon recovery

The Washington Department of Fish and Wildlife (WDFW) and Point No Point Treaty tribes released the “Summer Chum Salmon Conservation Initiative” in April of 2000, making it the first comprehensive regional conservation plan for a federally protected salmon population in western Washington. Summer chum stocks were listed as “threatened” under the Endangered Species Act (ESA) in March 1999, although their numbers had been increasing in recent years due to joint efforts by the state, the tribes, local citizen enhancement groups and the U.S. Fish and Wildlife Service.

State and tribal co-managers released the summer chum plan with the expectation that it would serve as the blueprint for bringing summer chum salmon on Hood Canal and the Strait of Juan de Fuca back from the brink of extinction. The plan was also sent to the National Marine Fisheries Service (NMFS), which is responsible for adopting recovery plans for salmon species listed under the ESA.

In developing the recovery plan, the state and tribal co-managers examined factors contributing to the decline in summer chum numbers, including harvest levels, hatchery practices, habitat, and other factors, and then developed specific recommendations to address each issue.

Efforts to reduce the catch of summer chum had been under way since the early 1990s, when the number of returning salmon plummeted to just a few thousand fish from as many as 75,000 in the mid-1970s. Starting in 1992, WDFW and the tribes carefully directed fisheries away from summer chum and reduced the “incidental” chum catch during other fisheries to extremely low levels.

To rebuild weak stocks and repopulate streams where summer chum are now extinct, fish are produced from eggs taken from naturally spawning stocks at five local “supplementation” projects on Hood Canal and three on the Strait of Juan de Fuca. The state and tribes have also made significant changes in hatchery practices for other salmon and trout species to avoid producing fish that might compete with wild summer chum.

To help improve habitat conditions for chum salmon, the plan recommended a variety of measures, including new restrictions on logging, bulkheads and other development, for each affected watershed. These recommendations were directed to a variety of jurisdictions, since the authority to protect and improve salmon habitat rests with a variety of local, state and federal governing bodies.

In the spring of 2001, the harvest management portion of the Summer Chum Salmon Conservation Initiative was accepted by the National Marine Fisheries Service as a recovery plan for summer chum salmon under section 4(d) of the ESA. In the fall of 2001, NMFS accorded the same ESA recovery plan status to the hatchery supplementation portion of the initiative.

As resource managers, the state and tribes exert direct control over the harvest and hatchery elements of the summer chum recovery plan. Harvests of summer chum have been substantially curtailed, with generally less than 10% of the returning fish being harvested in incidental fisheries conducted for other species. These low harvest rates have primarily resulted from time and area closures during periods of adult summer chum presence.

The resulting increased escapements have contributed to a pattern of generally increasing runsizes. Compared to the low point of 1,514 total returning summer chum in 1993, recent returns have improved substantially, with 5,103 and 10,375 fish returning in 1999 and 2000 respectively.

The supplementation of wild summer chum stocks using hatchery techniques has been extremely successful. Two supplementation projects initiated in 1992 (Big Quilcene River and Salmon Creek) are showing consistently strong returns, and a stock at high risk of extinction (Lilliwaup Creek) achieved a return of over 100 summer chum in 2001 as a result of supplementation efforts. Finally, two streams where summer chum had become extinct (Chimacum and Big Beef creeks) have been the sites of re-introduction programs, which successfully resulted in escapements of approximately 900 fish to each stream in the 2001 season.

Permitting Requirements

One major change brought about by the new listings was a significant increase in the amount of documentation required of state and tribal co-managers to conduct their respective management responsibilities. Almost all activities that affect salmonids and/or their habitat require some type of authorization from the NMFS or USFWS. The ESA provides several avenues for obtaining an incidental “take” authorization, which allows fishing for healthy stocks and minimal harvest of listed fish. All require state and tribal fishery managers to estimate the number of listed fish affected by these activities and document the results.

Below is a summary of the “take” exemptions that allowed WDFW to continue its management activities in listed waters during the 1999-01 Biennium.

- **Section 7:** Authorizations under Section 7 are available only where there is a federal government “nexus,” i.e., where a federal agency or tribal government is involved. WDFW has relied on Section 7 incidental take permits for ocean and Puget Sound fisheries established through the Pacific Fisheries Management Council and North of Falcon processes, and for Columbia River fisheries managed by joint state/tribal plans established under *U.S. v. Oregon*.
- **Section 10:** This section of the ESA allows permits to be issued for fisheries, scientific research or efforts to enhance the propagation or survival of listed species. WDFW has sought Section 10 permits to cover a number of fisheries, hatchery operations and research projects, particularly in areas with endangered listings.
- **Section 4(d):** In areas with threatened (but not endangered) species listings, this section of the ESA allows NMFS and USFWS to develop specific rules and exemptions for each listed ESU. NMFS defined 13 types of activities that can be exempted from the take prohibitions, provided certain criteria are met. These include provisions for harvest, hatchery, and research activities, as well as joint state/tribal management plans.
- **Hatchery Genetic Management Plans (HGMP):** The NMFS Section 4(d) rule identifies a take exemption for hatchery operations under an approved HGMP, which requires a thorough analysis of the effects of those operations on listed stocks. WDFW filed a total of 128 HGMPs with federal agencies during the 1999-01 Biennium, covering hatchery operations ranging from net pens in south Puget Sound to full-production facilities on the Columbia River.
- **Fisheries Management Evaluation Plans (FMEP):** The NMFS 4(d) rule also identifies a take exemption for harvest plans consistent with an approved FMEP. This approach may allow a longer-term authorization than is generally available through mechanisms such as Section 7. During the 1999-01 Biennium, WDFW submitted FMEPs to NMFS for the Lower Columbia tributaries, the Mid-Columbia tributaries and the Snake River and its tributaries.
- **Research Activities:** WDFW submitted more than 50 research projects to NMFS under this section of the 4(d) rule during the 1999-01 Biennium. Projects ranged from studies of juvenile salmon out-migration to research on how marine mammals and seabirds affect salmon populations.
- **Joint State/Tribal Resource Management Plans:** WDFW and tribal co-managers were already working on recovery plans for Puget Sound chinook and Hood Canal Summer chum salmon when those populations were listed under the ESA in 1999. The harvest components of the Summer Chum Salmon Conservation Initiative and the Comprehensive Chinook Plan for Puget Sound were approved by NMFS under the 4(d) rule during the 1999-01 Biennium. The harvest component of the Comprehensive Chinook plan was approved for a two-year interim period, through April, 2003. Additional elements of the plans, such as hatchery practices and habitat actions, have yet to be authorized by NMFS.

WDFW filed for a number of “take” exemptions based on the 4(d) rules established by NMFS in the following categories:

Local and Regional Planning

While fisheries and hatchery operations are largely the province of state and tribal co-managers, protection and restoration of salmon habitat is a responsibility shared with local governments and all of the citizens in a listed ESU. Integration of these various elements into a comprehensive recovery plan is the

focus of a number of local and regional salmon recovery efforts involving WDFW throughout the state.

As discussed in the Habitat section of this report, the Department played a key role in local recovery actions by providing technical support for Lead Entities and for established Regional Fisheries Enhancement Groups. These groups focused on habitat restoration projects within individual watersheds throughout the state.

In addition, WDFW participated in a number of forums designed to integrate these and other efforts into broad-scale, regional recovery plans. During the 1999-01 Biennium, NMFS established three Technical Recovery Teams (TRTs), responsible for developing recovery goals and monitoring standards for listed ESUs throughout the state. Comprised of six to nine scientists from both inside and outside government, the three TRTs began that process for listed populations in the Puget Sound area, the lower Columbia River and the mid- to upper Columbia River.

In developing recovery goals, TRTs are required to consider state and local strategies, and WDFW has been a major participant in that process in all areas of the state. For the Puget Sound region, the Comprehensive Chinook Plan and Summer Chum Salmon Conservation Initiative provided a starting place for the TRT's discussion about regional recovery goals as well as a roadmap for WDFW's own activities. There and elsewhere, the agency has been involved in several other regional planning efforts, also designed to dovetail with the TRTs' goal-setting mission. They include:

- **Lower Columbia Fish Recovery Board:** Created by state law in 1998, the Board include 15 representatives from city and county government, the Legislature, the Cowlitz Tribe, hydro-system operators, private landowners, the environmental community and concerned citizens. The Board's activities include assessing factors responsible for the decline of salmon and steelhead, participating in the development and implementation of the habitat portion of a recovery plan, coordinating other recovery planning efforts, and approving recovery projects and programs.

- **Puget Sound Salmon Forum:** The Puget Sound Salmon Forum is a non-profit organization created to implement the Shared Strategy for Puget Sound Salmon Recovery. The objective of the Shared Strategy is to connect existing efforts into a comprehensive recovery plan that integrates habitat, harvest and hatchery programs for the achievement of specific goals for fish populations in Puget Sound. The Strategy describes steps to be taken in development of a regional recovery plan. The Forum has been providing support and policy direction to scientists on the Puget Sound TRT and State/Tribal technical teams as they develop recovery goals for Puget Sound chinook.
- **Upper Columbia Fish Recovery Board:** Formed in 2000, the Board is working to develop a regional strategy for habitat protection and restoration in support of salmon recovery. The Board's Oversight Committee includes representation from Chelan, Douglas and Okanogan counties, the Yakama Nation and Confederated Colville Tribes. The full Board also includes cities, public utility districts, conservation districts, irrigation districts and others.
- **Snake River:** The Asotin Conservation District sponsored establishment of a Lead Entity in 1998 to develop salmon recovery project proposals for the state Salmon Recovery Funding Board. Representation includes Asotin, Garfield, Columbia and Walla Walla Conservation Districts; the Nez Perce and Umatilla tribes, the Washington Farm Bureau, WDFW, the state Department of Ecology, Regional Fisheries Enhancement Groups, the U.S. Forest Service, the Natural Resource Conservation Service, the Governor's Salmon Recovery Office and area citizens. NMFS and USFWS have also been invited to participate as work moves toward development of a regional biological strategy for habitat protection and restoration.
- **Yakima/Central Columbia:** A new Lead Entity has formed in the Yakima Basin during the 1999-01 Biennium with the support and participation of all 24 cities, three counties and the Yakama Nation. Currently, the new board is focusing on the identification and prioritization of salmon habitat projects and the development of a regional strategy for the Yakima Basin.

SALMON HARVEST

In 1999, a total of 900,000 salmon of all species was caught in commercial, recreational and tribal fisheries statewide, the lowest catch on record. Poor returns of most runs, combined with a range of new fishing restrictions designed to minimize impacts on stocks listed under the Endangered Species Act (ESA), depressed overall harvest levels in Puget Sound, the Pacific coast and the Columbia River.

In 2000, statewide harvest levels doubled to 1.75 million fish, reflecting improvements in both freshwater and ocean rearing conditions that benefitted salmon populations throughout the state. Although landings in 2000 were still well below the 1981-90 average of 8.6 million fish per year, the outlook for 2001 salmon fisheries indicated a better year ahead. Just two months before the close of the biennium, anglers harvested 26,000 spring chinook during a record return on the lower Columbia and forecasters accurately predicted the biggest run of coho off the Washington coast since 1985.

As in previous years, salmon seasons for 1999-01 were set through the North of Falcon and Pacific Fisheries Management Council (PFMC) processes, where state fishery managers work with tribal fishery managers, the federal government, other states and the public to design fisheries that achieve specific conservation and allocation goals. With the listing of seven additional salmonid regions under the ESA in March 1999, new federally approved "harvest ceilings" for listed populations placed additional constraints on fishing seasons throughout the biennium.

Tools for Selective Harvest

- Timing of seasons and openings
- Area closures
- Special area fisheries
- Size limits
- Gear restrictions (mesh size, bait, lures)
- Require release (certain species, unmarked fish)
- "New" gear types (beach seines, traps, fish wheels, tangle nets, weirs)

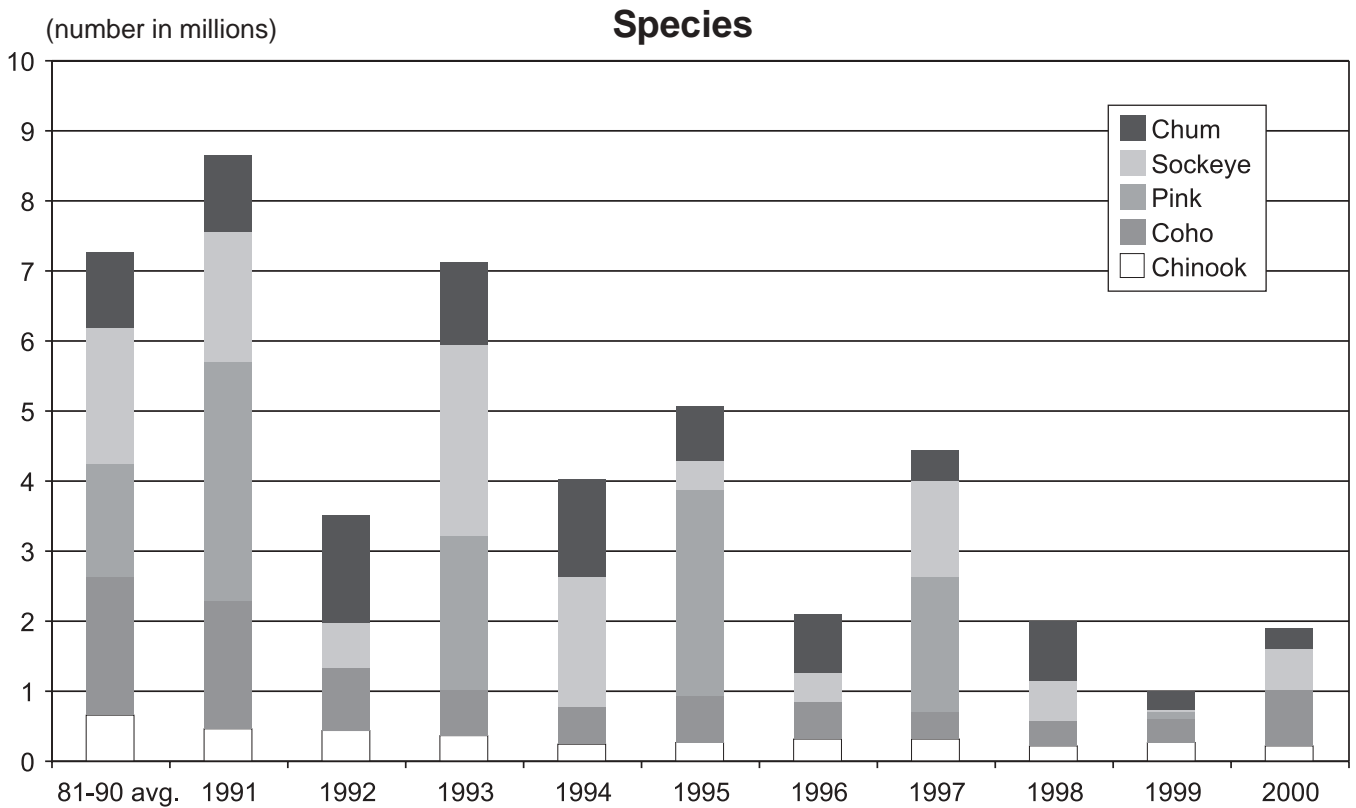
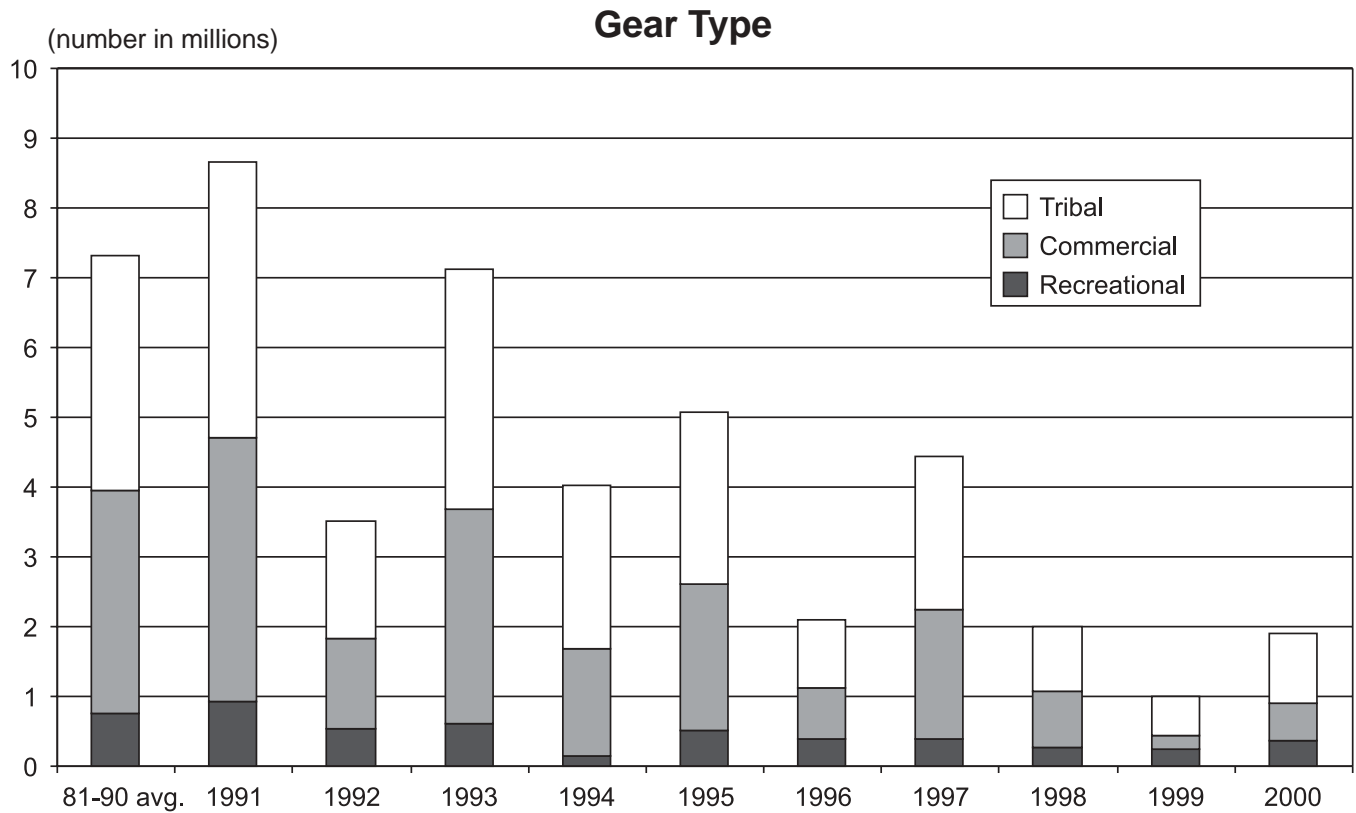


A WDFW biologist demonstrates the proper technique for using a dehooker to release an unmarked coho salmon caught in a selective fishery.

Under the new ESA harvest ceilings, harvest levels for many areas were determined by the potential effect on a listed stock, rather than the general abundance of salmon in those areas. The result was that many healthy wild and hatchery stocks could not be harvested, because the "take" of listed salmon would have likely exceeded allowable impact levels. Although the WDFW had been managing salmon fisheries to protect weak stocks for nearly two decades, the implementation of harvest ceilings for a large portion of the state's salmon fisheries had a significant effect on the overall catch.

As in previous years, WDFW took a number of actions designed to maximize fishing opportunities on plentiful wild and hatchery stocks, while allowing sufficient spawning escapement to maintain healthy runs and recover depressed stocks. New time and area closures were adopted to make fisheries more selective for healthy stocks. New gear

Statewide Salmon Harvest



restrictions were imposed and bag limits were reduced in a number of areas to reduce impacts on depressed and listed stocks, while still providing fisheries on healthy stocks.

But the biggest step toward achieving these goals came as a result of mass-marking hatchery stocks, which allowed for a major expansion of selective fisheries during the biennium. Beginning in 1996, WDFW began clipping the adipose fin of hatchery fish, making them easily identifiable to fishers on the fishing grounds. In the 1999-01 Biennium, for the first time, WDFW was able to develop regulations for a number of major fisheries requiring anglers to release any unmarked, wild salmon they caught.

By 1999, virtually all coho salmon released from state hatcheries in Puget Sound and on the coast were clipped, as were 95% of the coho and 100% of the spring chinook released on the Columbia River. During that year, the entire recreational ocean fishery for coho salmon was selective for hatchery coho, allowing anglers to target hatchery fish while releasing wild, unmarked coho. By 2000, a total of nine recreational marine fisheries and 43 freshwater fisheries had “gone selective” for coho, and the state’s first major selective chinook fishery took place in the Columbia River in the spring of 2001.

Without these selective fisheries, recreational opportunities would have been significantly restricted, affecting both fishers and local economies. Gear trials were initiated in 2000 to test the feasibility of selective commercial fisheries in future years, although expansion of the program may depend on future funding since these new types of commercial fisheries are costly to plan and execute.

Below is a summary of salmon fisheries in Puget Sound, the ocean, coastal bays and rivers, and Columbia River in the 1999-01 Biennium.

Puget Sound Salmon Fisheries

Poor returns of most species, combined with management efforts to minimize impacts on listed stocks, resulted in a record-low salmon harvest in Puget Sound in 1999. The combined catch by commercial,

Marked vs. Unmarked Salmon



A hatchery salmon (top) is easily identifiable by its missing adipose fin.

recreational and tribal fisheries that year totaled 503,500 salmon of all species, increasing to 1.3 million fish in 2000.

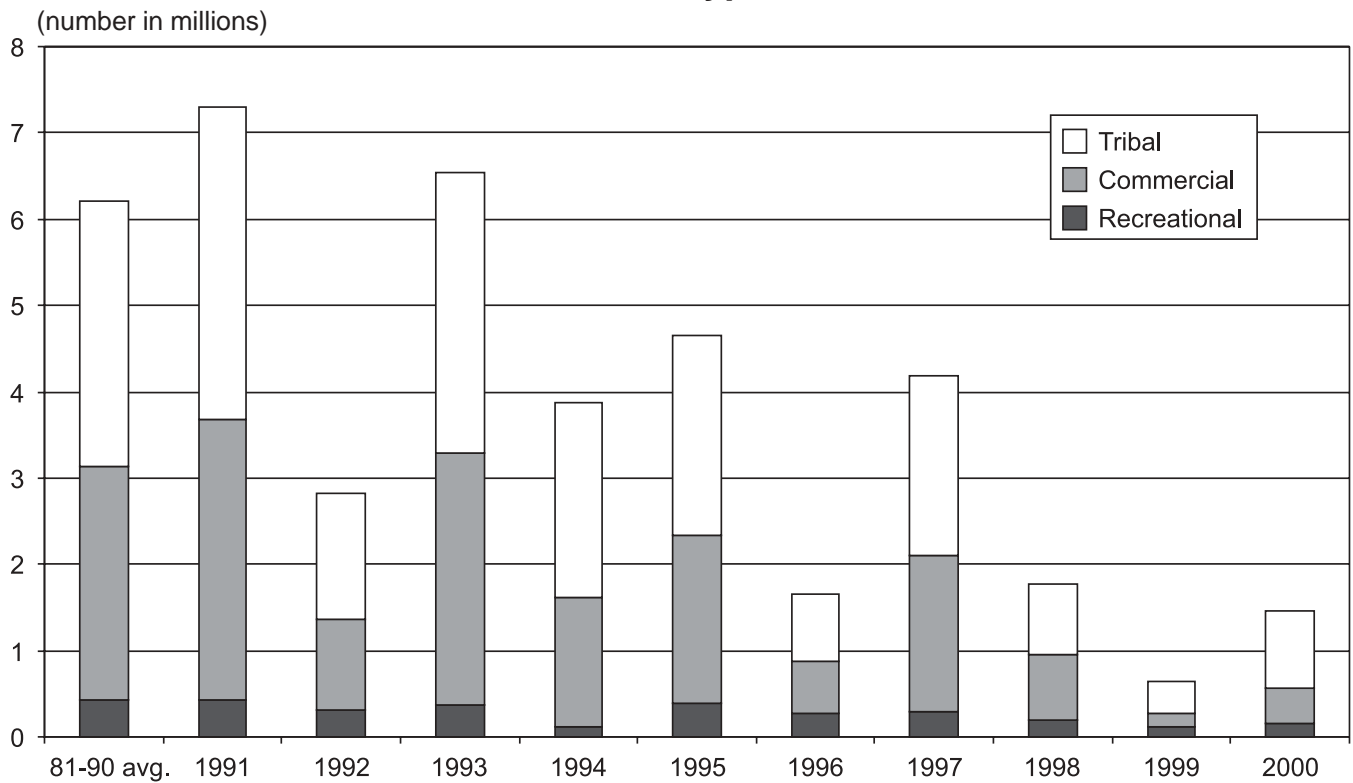
New time and area closures, gear restrictions, selective coho fisheries for anglers in the Strait of Juan de Fuca and a new catch-and-release fishery were just a few of the strategies employed by resource managers to protect depressed stocks and still provide fishing opportunities in Puget Sound. The NMFS reviewed all fishing seasons for compliance with the ESA, and WDFW monitored all commercial and recreational fisheries to the extent funding would allow.

For commercial fishers, the biggest setback of the biennium came in 1999, when an exceptionally weak run of Fraser River sockeye prompted the Pacific Salmon Commission to close the entire fishery that year. Recreational fishers had their share of setbacks, too, but there were also some bright moments. In 2000, Lake Washington was opened to sockeye fishing for only the second time since 1988, drawing thousands of anglers from throughout the region for a 13-day fishery.

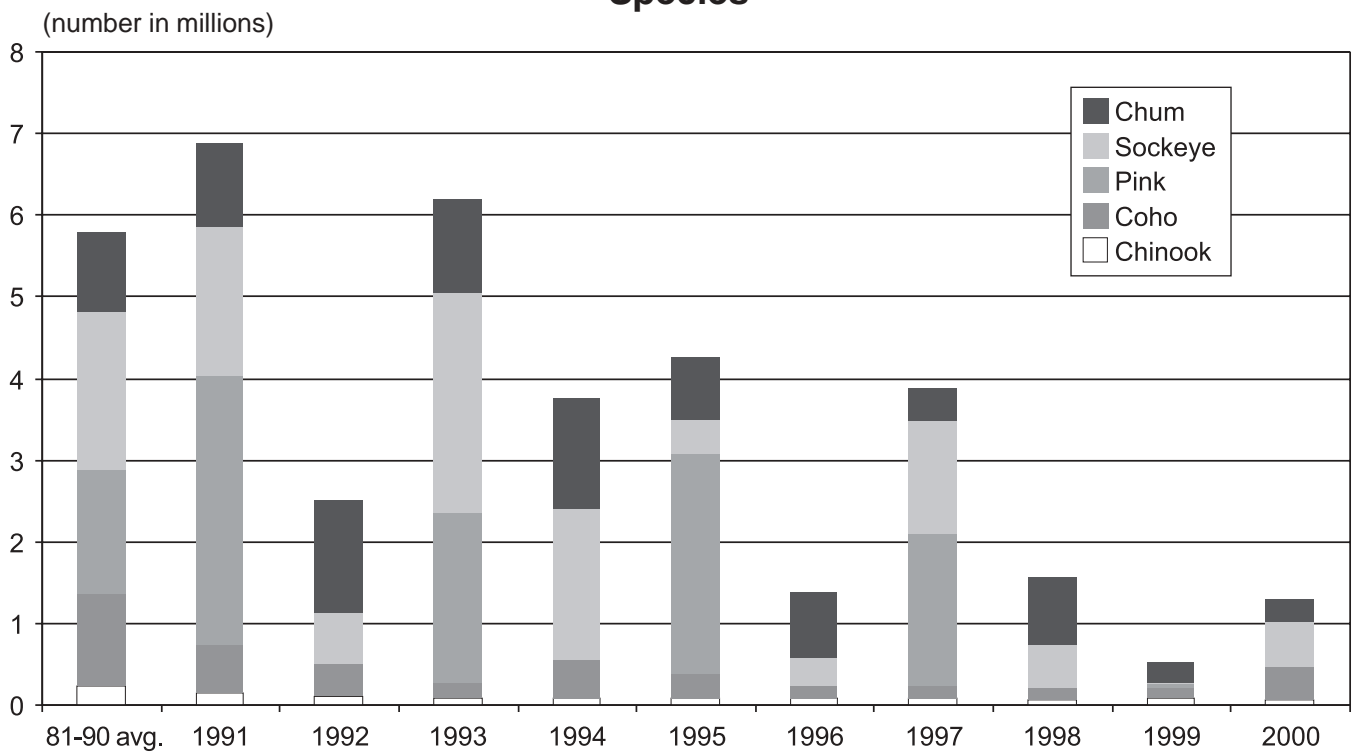
As in other areas, preliminary forecasts for 2001 suggested better prospects ahead for all types of salmon fishing, although most restrictions remained in place to protect listed species and other depressed wild stocks.

Puget Sound Salmon Harvest

Gear Type



Species



Recreational Fisheries

In 1999, anglers caught a total of 116,000 salmon of all species, rising to 207,000 fish in 2000. While run size increased for coho and most other species, fishing restrictions remained in place to protect listed chinook and summer chum stocks.

For most waters of Puget Sound, the recreational salmon fishery for each year of the biennium was compressed into two periods to avoid intercepting wild chinook. One period, in summer and early fall, was targeted primarily on hatchery coho. Another, focused on hatchery-produced blackmouth (immature chinook), was generally split between the month of November and a longer opening from mid-February through mid-April. Seasons were open somewhat longer in southern Puget Sound (Catch Areas 11 and 13) where the majority of chinook are from hatchery stocks.

In most areas, anglers were required to release any chinook caught in the summer/fall fishery. During the blackmouth season, the daily bag limit was restricted to one salmon of any species.

WDFW tried several new strategies to control fishing impacts on wild chinook. One involved limiting the amount of weight used to fish for salmon in certain areas, since chinook more frequently are found at greater depth than coho. In Marine Areas 5 and 6 (Sekiu and Port Angeles), fishing was closed within three-quarters of a mile of the shoreline, where the majority of chinook are encountered.

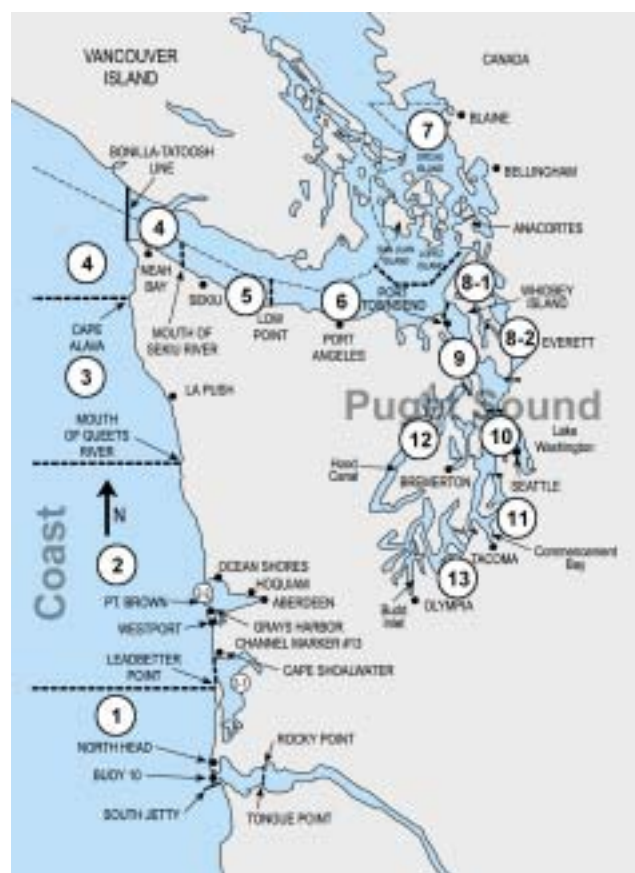
Other zonal fishing closures were timed to protect migrating adult chinook in Bellingham Bay and on the east and south sides of the San Juan Islands. Conversely, a chinook harvest zone was opened in Sinclair Inlet to take advantage of hatchery fish.

Starting in 1999, recreational coho fisheries in the Strait of Juan de Fuca became selective, requiring anglers to release any unmarked coho they caught. These fisheries were designed to reduce exploitation rates on depressed coho stocks such as the Canadian Thompson River coho run, a major issue of concern in negotiations between the United States and Canada. And, for the first time ever in Washington, a catch-and-release salmon season was established in south Puget Sound to provide angling opportunity while minimizing impacts on the resource.

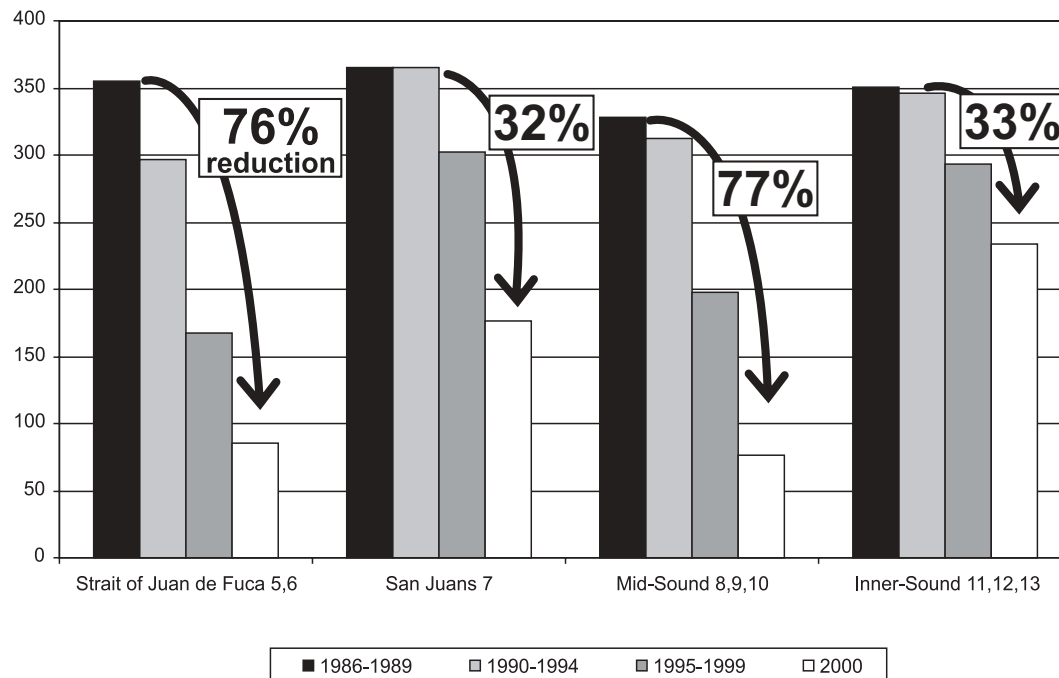
To evaluate the effectiveness of these special regulation regimes, WDFW conducted a number of special studies, involving coded wire tag data and biological indicators as well as basic scientific monitoring of the sport salmon fishery to collect species composition data. The selective fishery in the Strait of Juan de Fuca was intensively monitored to determine fishing encounter rates on-the-water, because many salmon caught in selective fisheries are not brought to the dock where they can be examined by fish checkers. A focused enforcement effort found that 98% of all recreational fishers contacted were in compliance with selective fishing rules.

In addition, a voluntary angler participation study was conducted in 1999 on the genetic origins of chinook in the San Juan Islands sport fishery to determine if there were differences by sub-areas. Another cooperative project in South Sound involved enlisting fly-fishers to maintain records of trips and catch to see if fly-fishing-only regulations in some areas might avoid adult chinook encounters.

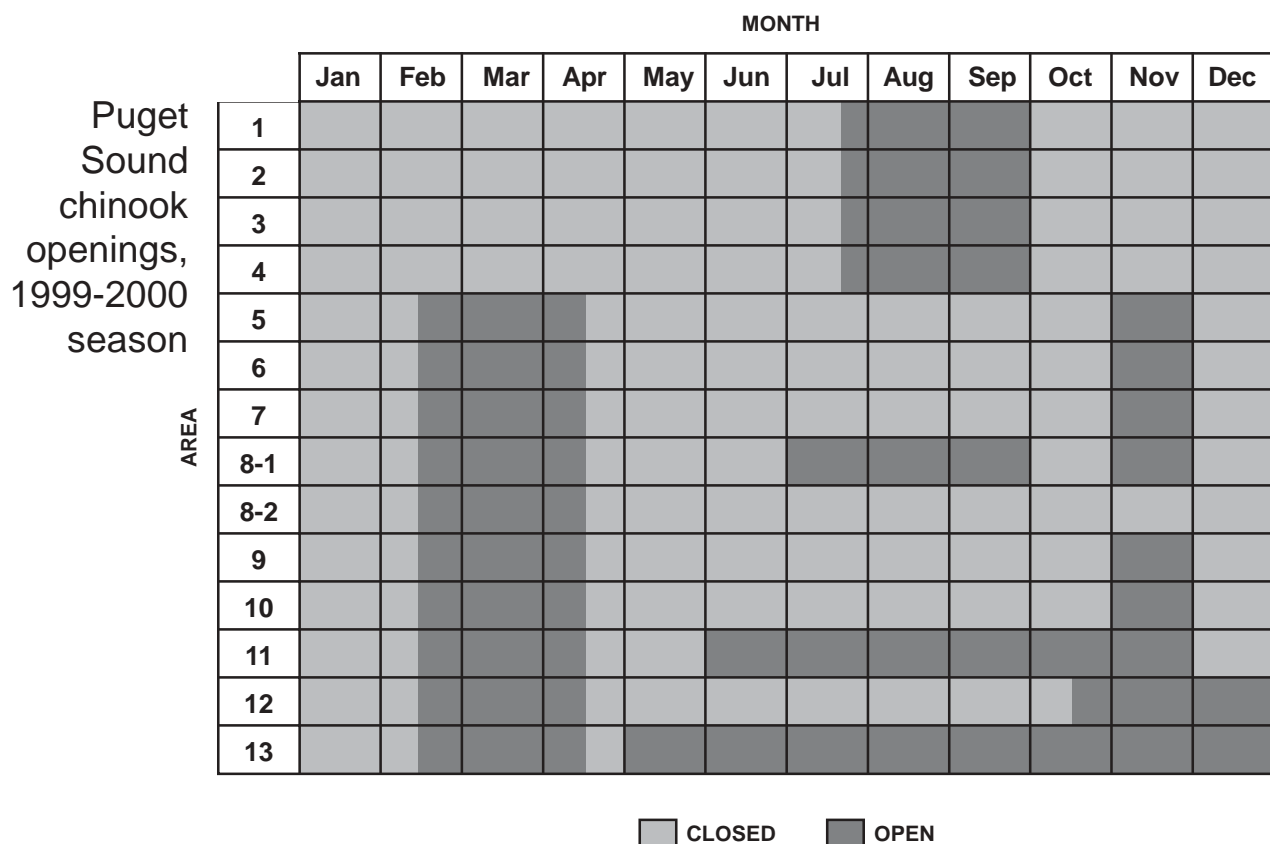
Marine Fishing Areas



Declining Recreational Salmon Fishing Opportunities in Puget Sound



Fewer days open to fishing since 1986



Commercial Fisheries

As in previous years, efforts to control by-catch of non-targeted species continued to play a major role in the management of Puget Sound net fisheries in the 1999-01 Biennium. WDFW implemented a number of new measures – from brailing requirements for seiners fishing for Fraser River sockeye and pink salmon to a ceiling on “chinook encounters” for certain areas and gear types – to minimize by-catch of wild chinook salmon by commercial fisheries during the biennium.

But the single most notable event for commercial fisheries was cancellation of the 1999 Fraser River sockeye season. When a pre-season run forecast 8.2 million Fraser River sockeye was downgraded to 3.3 million, the Fraser River Panel of the Pacific Salmon Commission (PSC) responded by canceling the fishery. Returns to the Chilko River, normally the largest component of the Fraser run, showed the lowest survival rate in 47 years.

Closure of Fraser River sockeye fishing produced a revenue loss estimated at more than \$4.8 million for the non-treaty fleet, and over \$9 million for the combined treaty and non-treaty fishing fleet. Only a small treaty sockeye catch in the Strait of Juan de Fuca occurred before the run was downgraded in size. The 2000 season in PSC waters produced a catch of 230,333 sockeye for non-treaty net fishers.

Cancellation of the Fraser River sockeye fishery was just one setback for reef net fishers, who had no salmon openings of any kind in 1999. The following year, reef netters caught 19,086 salmon, of which 17,957 were sockeye and a small number of coho and chum.

A key objective for management of 1999 Fraser River commercial fisheries was descriptive of the entire Puget Sound commercial salmon program for the biennium: “Minimize impact of chinook by-catch through avoidance of encounters where reasonable, and reduction of associated handling mortalities where practical.” WDFW employed a number of new strategies to meet that goal throughout Puget Sound.

Beginning in 1999, seiners were required to release chinook caught in all Puget Sound fisheries. In 2000, this requirement was extended to coho in most areas of the Sound. Seiners fishing for sockeye and pink

salmon in the San Juan Islands (Areas 7 and 7A) were also required to brail or dip-net their catch to minimize mortality of chinook salmon caught incidental to those fisheries.

In addition, chinook “encounter ceilings” were established for seiners and gillnetters in Fraser salmon fisheries, capping the number of chinook interceptions allowed whether or not they were retained. All net fishers involved in non-treaty Fraser Panel fisheries were required to keep logbooks of salmon by-catch by time, date and area. WDFW used this data to supplement direct by-catch monitoring efforts on the fishing grounds.

Fishing days varied from area to area during the biennium, but generally reflected the downward trend in stock abundances. Strong numbers of pink and sockeye salmon that had helped to sustain the fishery in earlier years were not evident at the close of the decade, and chum salmon catches were also down. The low abundance of chinook and some coho stocks, together with a new Fish and Wildlife Commission policy favoring recreational fisheries for these species, also reduced the commercial salmon harvest.

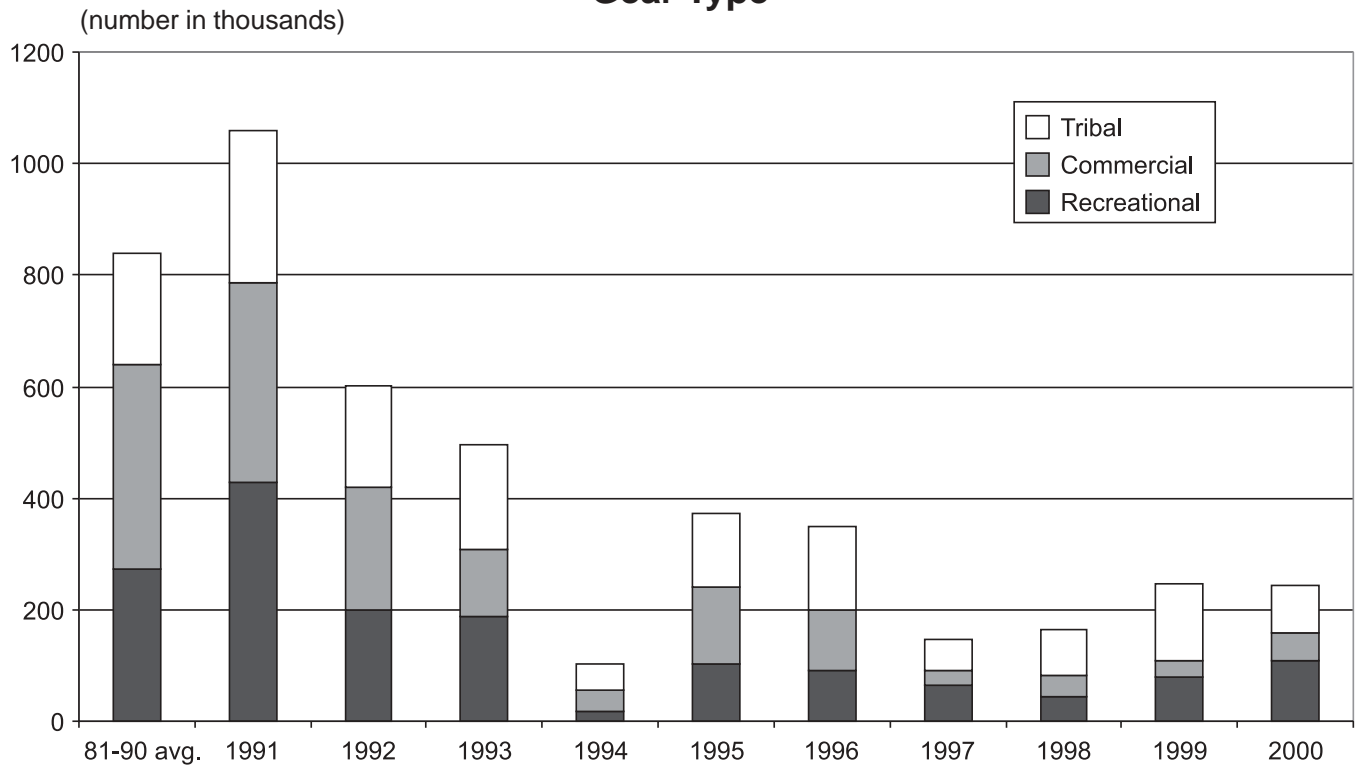
Bellingham Bay was the only area in Puget Sound with a non-treaty commercial net fishery directed at chinook salmon. Primarily a gill-net fishery, the commercial harvest is designed to catch excess fish above the number needed for broodstock at Samish Hatchery. Preliminary data indicate that 9,211 were caught in 1999 and 11,396 in 2000, respectively represent-



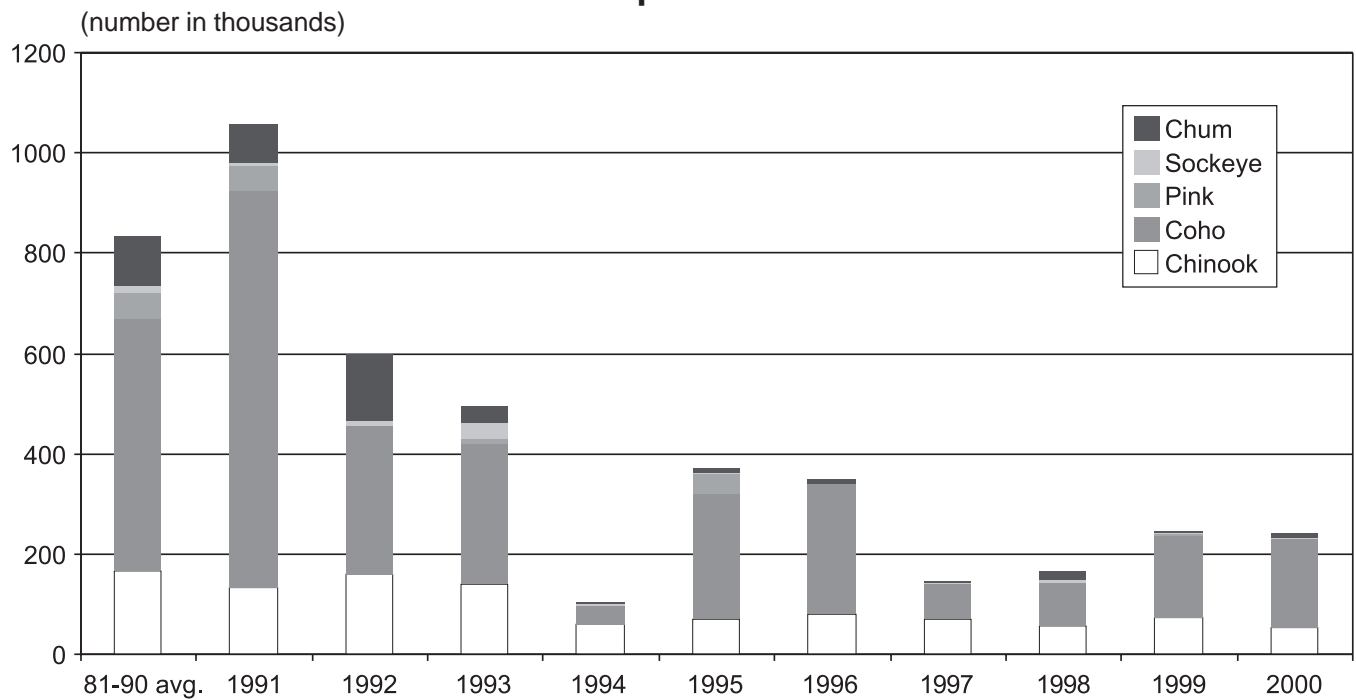
A purse seiner makes a set in Hood Canal, where low chum returns in 1999 and 2000 contributed to poor commercial salmon catches in Puget Sound. – Jon Anderson/WDFW

Ocean Catch Salmon Harvest

Gear Type



Species



ing 62% and 77% of the average chinook catch for the area over the decade. Bellingham Bay also accounted for the majority of the coho salmon harvested by non-treaty commercial fishers during the biennium, with hatchery fish comprising about three-quarters of the coho catch.

In a good year, a small group of skiff gillnet fishers who ply the shallow waters of Dungeness Bay can account for up to 15% of the total non-treaty commercial coho catch in Puget Sound. In 1999, however, this group caught only 700 fish, followed by a catch of 3,500 coho in 2000.

Compared to the average catch over the years 1991-1998, catches of chum salmon in all areas of Puget Sound were down 74% in 1999 and 71% in 2000. This decline can be attributed primarily to low returns in south Puget Sound (Areas 10 and 11) and Hood Canal (Areas 12 and 12B), which support the bulk of the commercial chum salmon catch in the Sound.

Ocean Salmon Fisheries

As in most other years since the mid-1990s, total salmon landings during the 1999 ocean fishery were very low. Catch rates for coho picked up substan-

tially in 2000, but fisheries were constrained by reduced harvest quotas designed to protect a variety of depressed stocks from northern Puget Sound to the Oregon coast.

Not until 2001, when the coho quota was triple that of the year before, did ocean fishers look forward to a truly good year. Although final catch figures for 2001 are not yet available, initial indications are that the coastwide salmon harvest for that year was the highest since 1991.

Salmon fisheries in all three years would have been even more limited if not for the coastwide implementation of selective coho fisheries in 1999. By requiring anglers to release all unmarked coho, this new policy allowed WDFW to keep recreational ocean fisheries open throughout the summer season in 1999. In 2000, the six-week season would have been reduced to a week or ten days without the protection afforded by selective fishing to weak, wild stocks.

For management purposes, ocean salmon fisheries are divided into four areas: Marine Area 1 (Ilwaco), Area 2 (Westport), Area 3 (La Push) and Area 4 (Neah Bay). Summaries of ocean salmon seasons for 1999 and 2000 follow on the next page.

Buy-back program nets 528 commercial licenses

When the Pacific Salmon Treaty with Canada was renegotiated in 1999, the federal government committed \$30 million to help offset economic losses to Washington fishers resulting from an agreement to reduce interceptions of sockeye salmon returning to the Fraser River. WDFW received \$24.5 million of that amount, plus \$2.34 million in state funds, in the 1999-01 Biennium to administer a permit buyback program for commercial fishers affected by those cutbacks.

The Department purchased a total of 528 commercial licenses during the biennium from fishers in areas including Puget Sound, the Pacific coast, Grays Harbor and Willapa Bay. In the Puget

Sound area, WDFW paid a fixed price of \$103,300 for a purse seine license, \$27,500 for a gillnet license and \$57,595 for a reef net license. Forty-one coastal trollers sold their licenses back to the state for \$7,500 each and WDFW purchased 35 charter-boat licenses for \$4,000 to \$10,000 each, based on several criteria. In Grays Harbor and Willapa Bay, 22 fishers received \$12,500 to \$25,000 for their licenses, depending on gear type and harvest history.

WDFW applied a 3% overhead charge to meet the cost of administering the program. A final installment of \$5.4 million in federal support for the program was expected in the spring of 2002.

1999 Ocean Salmon Fishery

Ocean harvest quotas for non-treaty fishers in 1999 were 50,000 chinook (21,500 sport and 28,500 non-treaty troll) and 130,000 coho (110,000 sport and 20,000 non-treaty troll). For tribal fisheries, which traditionally take a larger portion of their catch allocation in "inside" fisheries, the quotas were 30,000 chinook and 38,500 coho.

These quotas, established by the Pacific Fisheries Management Council (PFMC), reflect the general low abundance of these species and management efforts to lower fishery impacts to specific depressed stocks. For chinook, the "driving stock" (needing the most protection) was lower Columbia River wild chinook (Lewis River). For coho, the driving stocks were Queets River wild coho, Strait of Juan de Fuca wild coho and Oregon coastal natural coho. The latter stock is listed as threatened under the ESA.

All four ocean areas opened for recreational fishing on July 19. Because salmon abundance and angler effort were both low, these fisheries remained open through the season closing date of September 30. All four ocean areas were selective for hatchery coho, reducing impacts on weak wild stocks. If the recreational fisheries had not been selective for fin-clipped coho, fisheries managers estimate they would have closed in a month or less.

There were 58,200 angler trips reported for the recreational salmon fishery, with a catch of 10,800 chinook and 47,700 coho for the 1999 season. WDFW employees were placed on some charter boats to record the number of unmarked coho being released in the fishery in order to account for non-landed mortality.

The commercial non-treaty troll fishery was open from May 1 to June 15 for a chinook-only fishery and reopened on July 10 through September 30 for a chinook and coho (non-selective) fishery. The commercial troll fishery had a catch of 17,600 chinook and 4,000 coho for the season.

Tribal fisheries opened for chinook only from May through June and for all species from August 1-6 and from Aug. 10-15. In all, tribal trollers caught 27,664 chinook and 33,347 coho in 1999.

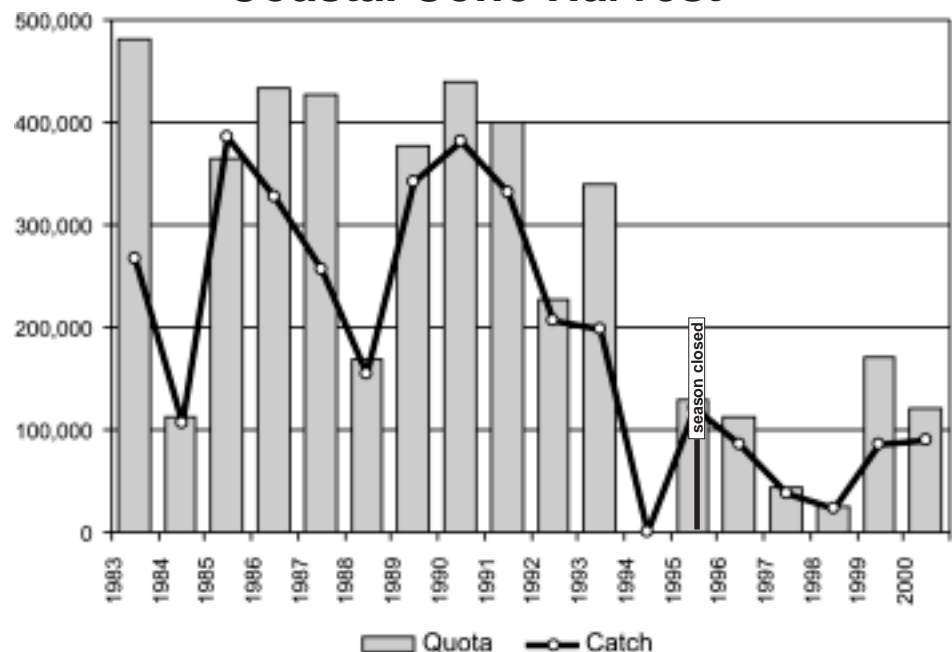
2000 Ocean Salmon Fishery

Ocean harvest quotas for non-treaty fishers in 2000 were 25,000 chinook (12,500 sport and 12,500 non-treaty troll) and 100,000 coho (75,000 sport and 25,000 non-treaty troll). For tribal troll fisheries, the quotas were 25,000 chinook and 20,000 coho.

Seasons were designed to lower fishery impacts to a number of depressed stocks. The driving stocks for chinook were lower Columbia River wild chinook (Lewis River) and lower Columbia River hatchery (Tule) stocks, both listed as threatened under the ESA. The driving stocks for coho were Queets River wild coho, Strait of Juan De Fuca wild coho, Skagit River wild coho, Stillaguamish River wild coho, Snohomish River wild coho and Oregon coastal natural coho. The latter stock is listed as threatened under the ESA.

Three ocean areas opened for recreational fishing on July 3; the fourth, Area 1 (Ilwaco), opened July 10. All four ocean areas were selective for hatchery coho, closing in mid-August after a season of approximately six weeks. If not for selective fishing requirements, fisheries managers estimate that all areas would have closed in a week to ten days.

Coastal Coho Harvest



There were 53,900 angler trips reported for the recreational salmon fishery, with a catch of 9,900 chinook and 77,500 coho for the 2000 season. Again, WDFW employees were placed on charter boats to record the number of unmarked coho being released in the fishery in order to account for non-landed mortality.

The commercial non-treaty troll fishery was open from May 1 to June 15 for a chinook-only fishery, and reopened on Aug. 4 through Sept. 5 for a chinook and selective coho fishery. This was the first year that the commercial troll fishery was selective on fin-clipped coho. The commercial troll fishery caught 12,900 chinook and 17,300 coho for the season. A logbook program as well as a ride-along program were put in place to monitor the catch.

Tribal fisheries were open for chinook only in May and June, and for chinook and coho from August 1-11.

Coastal Bays and Harbors

This section provides a brief review of salmon fisheries in Washington's coastal bays (Willapa Bay and Grays Harbor) and coastal rivers in 1999 and 2000.

Willapa Bay

Willapa Bay is one of the few areas in the state where there are no treaty fishing rights; therefore, only non-tribal commercial and recreational fisheries occur within the Bay. The 1999 season was marked by low returns and low harvest levels. In 2000, both returns and overall harvest levels increased for chinook, coho and chum salmon, although chinook still fell short of escapement goals. The 2000 fishery marked the first year under the newly developed "Willapa Bay Fishery Management Framework Plan," developed in conjunction with Bay fishers. (See next page.)

1999 Fisheries

The 1999 season was a difficult year for salmon management in Willapa Bay. Using the best available information, WDFW Fish Management staff set seasons with input from commercial and recreational fishers through the North of Falcon process, giving first priority to conservation of the resource and, secondly, to optimizing fishing opportunities for rec-

reational and commercial fisheries. Two key considerations in 1999 were: (1) the pre-season forecast for chinook of 14,900 was expected to be the lowest chinook return to Willapa Bay since 1984, and (2) an in-season estimate of chum abundance indicated that the run was returning much lower than expected and below spawning escapement needs.

Based on pre-season expectations, the traditional one-day, full-fleet commercial "chinook update fishery" in late August was not conducted. Instead the limited number of chinook available for harvest were used to maximize fishing opportunities for hatchery coho due to a significant overlap in run timing. A total of eight days (including one day of daylight only) were open to targeted coho gillnet fishing.

During the gillnet fishery, it became clear that the chinook run, then the chum run, were coming in below expectations. WDFW took several actions to reduce pressure on these stocks, while looking for ways to maintain commercial and recreational fishing opportunities. The coho fishery was confined to Area 2G west of Channel Marker 24 in an effort to minimize chinook impacts. Because early chum catches in the coho fishery were much lower than expected and Grays Harbor chum catches indicated the same trend, WDFW also closed a chum-directed gillnet fishery proposed for eight days in late October.

For recreational fisheries, regulations were designed to optimize marine and freshwater recreational opportunities to harvest chinook and hatchery coho and some chum. The only significant change from 1998 regulations was a reduction in the adult daily bag limit from 3 to 2 fish in marine waters (Area 2-1). These seasons and changes were supported by the recreational representatives at the North of Falcon meetings.

Early hatchery returns for chinook appeared much lower than expected, even given the low pre-season forecast. Fish Management staff reviewed the historical hatchery return data, which strongly suggested that chinook egg take needs would not be met. As a result, WDFW closed all freshwater areas to retention of chinook by recreational anglers by emergency regulation. The marine sport fishery inside the bay was not closed to the retention of adult chinook, both because the impacts would be low and because it

Willapa Bay Fishery Management Framework

In November 1999, WDFW representatives began meeting with key constituents of the Willapa Bay commercial and recreational fisheries to develop a regional planning process specific to Bay fisheries. The plan ultimately approved and implemented during the 2000 season not only laid the foundation for Willapa Bay fisheries in that and future years, but also provided a model for joint regional planning efforts in other areas of the state.

Management goals established under the plan for the 2000 season include:

- **Natural origin chinook:** Increase the spawning escapement by 17% over the 1996 brood escapement.
- **Natural origin coho:** Increase escapement by 25% over the 1997 parent year. This escapement objective was increased from an original objective of 20% above the brood year escapement due to the desire by recreational fishing representatives to forego harvest opportunity on wild coho and pass half of the savings from selective fisheries into escapement.
- **Natural origin chum:** Meet the wild escapement goal of 35,400.

The Fish and Wildlife Commission recognized the need for region-specific management plans in February 1999, when fishers from several areas – including Willapa Bay – raised concerns about broad harvest priorities established for various salmon species. Under those statewide priorities, chinook and coho were identified as the primary target species for the recreational fishery and pink, chum and sockeye were identified as the primary target species for the commercial fishery.

The objections stemmed from the fact that these statewide priorities did not recognize the lack

of pink and sockeye stocks in southwest Washington or the long history of directed commercial chinook and coho fisheries in Willapa Bay, Grays Harbor, the lower Columbia River and the Pacific Ocean. In response, the Commission directed WDFW to initiate a regional planning process in the year 2000.

Willapa Bay was chosen for this initial effort in 2000 for two primary reasons. First, disagreements between fishers and WDFW over pre-season and in-season management decisions in 1999 indicated the need for establishing clear management objectives and guidelines for conducting the region's fisheries. Second, WDFW saw this as an important step toward maintaining and increasing natural spawning populations, while also maintaining strong hatchery programs in Willapa Bay.

From the outset of the 2000 planning process, representatives of WDFW, the commercial fishery and the recreational fishery discussed long-term goals for Willapa Bay that would lead to more sustainable fishing opportunities, while providing ecological benefits from both natural and hatchery salmon populations in the basin. Abundant natural spawners, improvements in hatchery programs, accurate assessments of the resource and the ability to adapt to new information and new ideas – these were all elements of the long-term goals discussed by participants at the planning meetings.

An initial plan was developed and the objectives and elements of the Plan were then used in planning specific fisheries for salmon and sturgeon in the 2000 season. After the 2000 season, WDFW and the fishery representatives reviewed elements of the plan and those that needed improvement. Refinements were made to the plan for 2001 through additional meetings with key constituents, providing clear objectives and expectations for the next season's fisheries.

would be unfair to do so given the gill-net harvest opportunities for chinook in the same area and time.

Early spawning ground surveys also confirmed previous indications of a low chum run. Although the expected impacts of recreational fishing on chum were low, all freshwater areas were closed by emergency regulation to the retention of chum.

Post-season information on hatchery returns and natural spawning escapements confirmed that the chinook return was even lower than the pre-season forecast, and hatchery chinook egg-take goals were not met. Chum returns were also below the escapement goal, as indicated by the in-season information.

2000 Fisheries

The 2000 salmon season for Willapa Bay was guided by the newly developed “Year 2000 Willapa Bay

Fishery Management Framework Plan,” developed in conjunction with Bay fishers. As noted on the adjacent page, the plan established specific escapement goals for chinook, coho and chum salmon of natural origin in the Bay.

Regulations for recreational fisheries were designed to optimize marine and freshwater fishing opportunities to harvest chinook and hatchery coho and some chum. As in other recent years, there was a requirement to release all wild coho in both marine and freshwater areas. Several new freshwater regulations – including requiring the release of adult chinook in non-hatchery streams – were implemented to reduce impacts to natural origin coho and chinook. In addition, a special regulation requiring constant movement of the bait or lure was enacted on the Naselle River to reduce snagging. This new approach was found to work well.

Commercial fishing seasons were established with direct input from fishers involved in the pre-season planning process. A number of different time and area strategies were implemented and evaluated in 2000 to provide fishery flexibility while meeting stock management objectives identified in the new Framework Plan. Information gained from mass marking of coho in previous years indicated an earlier run timing for hatchery fish than previously thought, allowing fisheries managers to design a fishery that targeted hatchery coho while meeting natural coho spawning escapement objectives.

A total of 21 days of commercial gillnetting directed at salmon occurred in 2000 (including two days of daylight only), with no changes to the pre-season schedule based on in-season information.

Post-season information indicated that the total chinook run into Willapa Bay returned at 81% of the pre-season forecast and lower than in-season information indicated. For the third year in a row, total chinook egg-take needs for on-station releases were not met for the Willapa Bay hatcheries. Hatchery egg take needs were approximately 70% of the amount necessary to meet on-station release goals. The return of natural origin-chinook (produced by natural spawners) was 80% of expectations, and the estimated escapement of these 2,303 fish was only 7% over the brood escapement. By comparison, the goal established by the Framework Plan was a 17% increase over the 1996 brood escapement.



A shore-based angler plays a chum salmon, which began to decline in 1999 and 2000 from near historic levels.

Coho returns were above pre-season expectations for both hatchery and natural runs. The estimated natural escapement was 24,100, exceeding both the interim natural escapement goal of 13,090 and the goal established under the Framework Plan (25% over the 1997 escapement).

The chum return of 46,720 fish was only 68% of the pre-season prediction of 69,188. The estimated wild chum escapement was approximately 40,000, which met the wild escapement goal of 35,400.

Grays Harbor

Following the same pattern as Willapa Bay and most other state waters, salmon landings were extremely low in Grays Harbor in 1999, followed by a somewhat higher catch in 2000. Both treaty and non-treaty fisheries occur within Grays Harbor and its tributaries. The Quinault Indian Nation exercises treaty fishing rights in the marine area and in the Chehalis and Humptulips rivers. In addition, members of the Chehalis Tribe, a non-treaty tribe, have fishing rights on the Chehalis River within the boundaries of their reservation. In 1999, a federal court decision held that catches by the Chehalis tribe count against the non-treaty share of harvestable fish, which affected catch allocations for non-treaty commercial and recreational fisheries in 1999 and 2000.

1999 Fisheries

Recreational and commercial fisheries in Grays Harbor and its tributaries in 1999 were limited by the expected low return of fall chinook to both the Humptulips and Chehalis River basins. In addition, Humptulips wild coho were expected to return below the spawning escapement goal.

Anglers were required to release any adult fall chinook caught in marine waters (Area 2-2) and freshwater areas. As in 1998, a selective fishery for hatchery coho was in place for the Humptulips River recreational fishery to protect returning wild fish. Beginning in 1999, a fishery targeting hatchery coho returns from net pen releases was established in the Ocean Shores boat basin to provide additional recreational fishing opportunity. This fishery was similar to the one in place for many years in the Westport boat basin. An estimated 275 chinook, 4,570 coho and 24 chum were taken by anglers in 1999 in Grays Harbor and its tributaries.

The commercial gillnet fishery was open for a total of four days targeting coho salmon and resulted in catches of 87 chinook, 1,674 coho and 37 chum.

2000 Fisheries

In 2000, both the chinook and wild coho runs destined for the Chehalis River were expected to provide limited numbers of fish available for harvest. Recreational and commercial fisheries were designed to harvest Chehalis River wild coho available to the non-Indian fisheries.

On the Humptulips River, where wild coho were again expected to return below the spawning escapement goal, selective fishing rules required anglers to release all wild coho, as well as adult chinook. In the marine area (Area 2-2) and Chehalis River tributaries, anglers were restricted to only one adult wild coho as part of their daily limit. According to preliminary estimates, recreational fishers caught approximately 1,850 chinook, 5,245 coho and 375 chum salmon in Grays Harbor and its tributaries in 2000.

The commercial gillnet fishery was open for six days (including one day of daylight only) and resulted in catches of 1,318 chinook, 4,995 coho and 387 chum.

North Coastal Rivers

In-river fisheries on the Quinault, Queets, Hoh and Quillayute river systems as well as some smaller independent tributaries are managed for recreational and tribal fisheries. As in previous years, WDFW worked closely with each tribe during the biennium to maximize fishing opportunities as warranted by the strength of each salmon stock and the conservation needs for each year.

- **Quinault River:** Fishing was restricted to jacks only from July through October as in previous years. Anglers caught three fish in 1999 and 135 in 2000.
- **Queets River:** The mainstem Queets River above the Quinault Reservation flows through Olympic National Park land. As in previous years, WDFW worked closely with parks staff, who establish regulations for salmon on the Queets. There is also a very small portion of land along the Salmon River, a Queets tributary that

is not part of the Quinault Reservation. A selective fishery for hatchery coho was implemented in 1999 and for chinook and coho in 2000. The combined recreational catch for the Queets/Clearwater/Salmon River fishery, including jacks, was 273 salmon in 1999 and 402 in 2000.

- **Hoh River:** Low returns of wild spring/summer chinook restricted fishing opportunities throughout the biennium. In 1999, fishing below Highway 101 was limited to jacks only during a season that ran from June through August. In 2000, anglers were also allowed to retain any straying hatchery chinook they encountered as well as early returning coho. Beginning in 1999, WDFW opened the area upstream of Highway 101 to provide additional recreational fishing opportunities for harvestable fall chinook and coho. This area previously had been closed to the taking of adult salmon for a number of years. The total recreational catch of salmon, including jacks, in the Hoh River was 907 fish in 1999 and 861 in 2000.
- **Quillayute River System:** The Quillayute River and a portion of the Sol Duc River were open for adult and jack salmon from March 1 through November 30 in 1999. Portions of the Bogachiel and Calawah Rivers were open from July 1 through November 30 that year. In 2000 a selective fishery for hatchery coho and hatchery chinook was implemented on all the rivers open for salmon to protect low returns of wild summer coho and wild summer chinook expected that year. The total recreational salmon catch, including jacks, for the Quillayute River system was 2,370 fish in 1999 and 2,444 in 2000.

Columbia River Salmon Fisheries

As in most other state waters, the total salmon harvest in all mainstem Columbia River fisheries picked up significantly after poor returns in 1998 and 1999. Led in large part by increasing returns of hatchery coho stocks, total landings by both tribal and non-tribal fisheries rose from 171,000 salmon in 1999 to 226,800 fish in 2000. In 2001, the year



Anglers line the shore below Bonneville Dam for the 2001 Columbia River spring chinook fishery.

started with the largest harvest of upper Columbia spring chinook since 1973, followed by the highest coho forecast in two decades.

Total catch figures for 2001 are not yet available, but it appears that most runs were very strong, as indicated by WDFW's pre-season forecast. While still well below the 1981-1990 average of 493,600 salmon, total landings by all fisheries in the mainstem Columbia were expected to be the highest since the early 1990s.

Salmon management on the Columbia and Snake rivers is virtually unparalleled in its complexity, shaped by numerous governmental bodies and individual salmon stocks – six of which are listed under the ESA. One major breakthrough during the 1999-01 Biennium was the adoption of a multi-year plan designed to rebuild Snake River spring and summer chinook, Upper Columbia spring chinook and Snake River sockeye. The plan establishes conservation goals for all four population groupings, with provisions to adjust harvest rates to the number of fish projected to return in a given year. Signatories to the agreement include the states of Washington and Oregon, the federal government and four Columbia River treaty tribes.

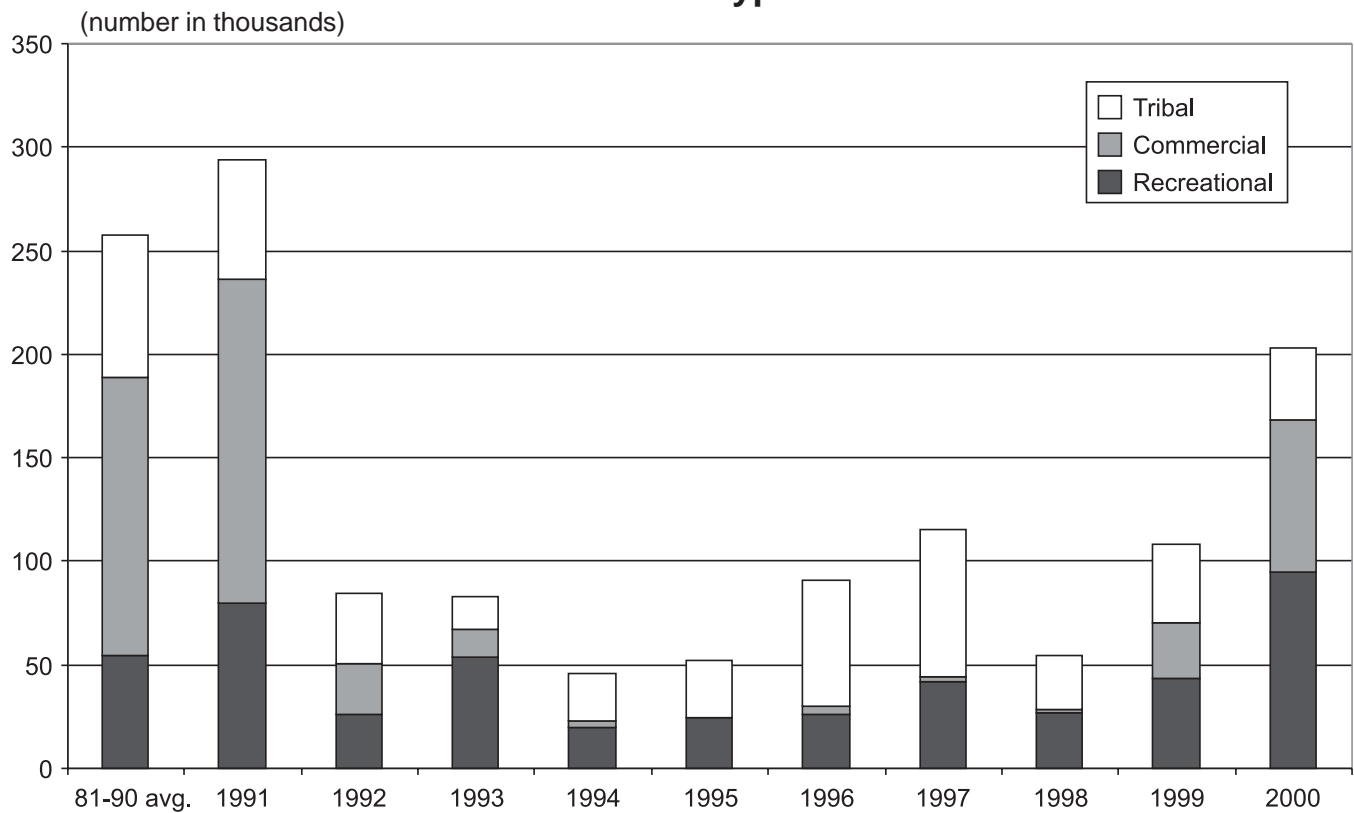
Spring Fisheries

Lower Columbia River Fisheries

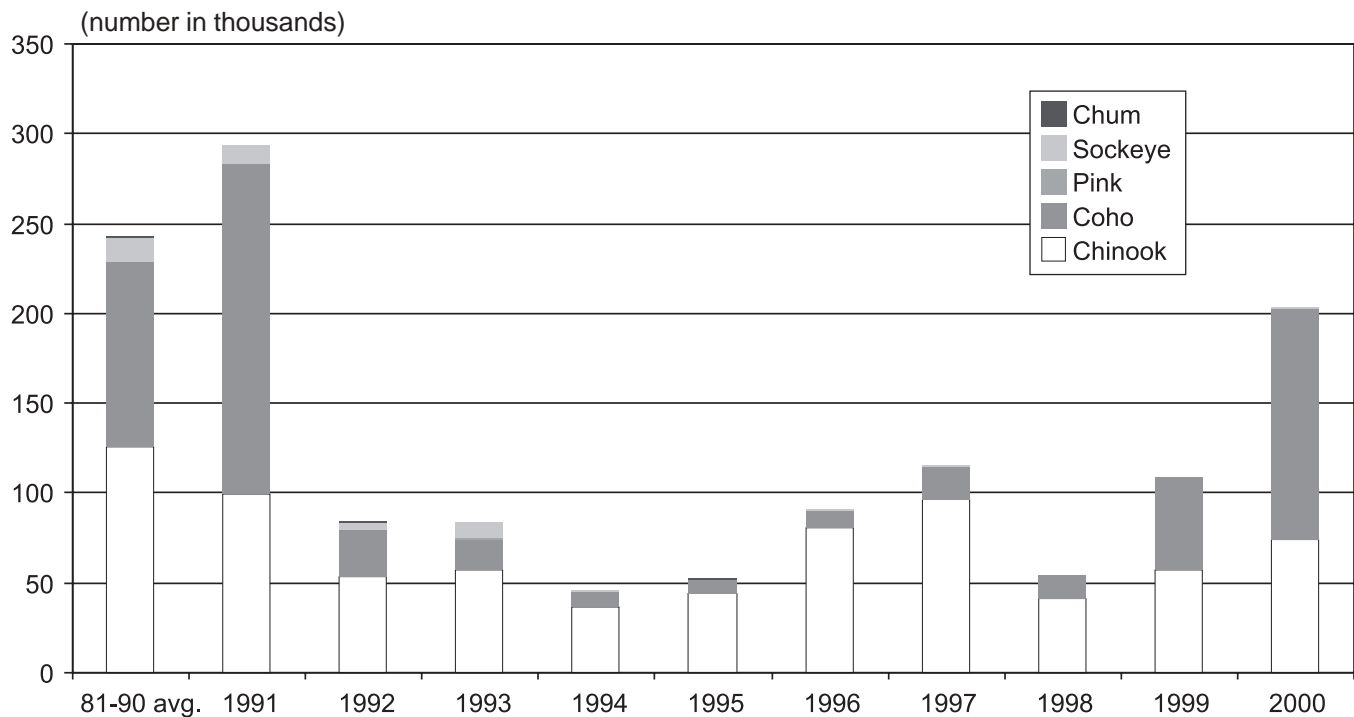
After poor returns and non-tribal landings of just a few hundred fish in 1999 and 2000, spring chinook salmon returned to the Willamette and Snake rivers in record numbers in 2001. Anticipating a run of over

Columbia River Catch Salmon Harvest

Gear Type



Species



400,000 fish, WDFW opened a recreational fishery below Interstate 5 on January 1, then opened fishing upstream to Bonneville Dam for most of April, resulting in a non-tribal harvest of 26,000 hatchery spring chinook. Anglers were required to release all chinook without clipped adipose fins, marking the first selective fishery ever held on spring chinook in the Columbia River. The 2001 spring chinook fishery produced 172,000 angler trips and the largest catch since 1973. According to estimates by the Northwest Sportfishing Association, economic benefits to local communities exceeded \$15 million. The area above the mouth of the Willamette River had not been open since the 1970s because of poor returns of upriver spring chinook.

Spring chinook returning in 2001 to federal hatcheries on the Wind River and Little White Salmon River also contributed to record sport fishery catches. The Wind River produced a catch of 11,500 spring chinook while Drano Lake (Little White Salmon River) produced a harvest of 3,100 spring chinook.

Fisheries targeting upriver spring chinook have not occurred in the Columbia River since the 1970s. Since then, both sport and commercial fisheries focused on the earlier timed Willamette spring chinook. In 1999 and 2000, the commercial fishery harvested less than 500 spring chinook each year. The sport fishery in the Columbia River in those years closed in mid-March with overall catches of less than 400 fish.

As discussed in the Salmon Science section of this report, WDFW worked with the Oregon Department of Fish and Wildlife in 2001 to test the feasibility of using live capture methods in Columbia River commercial spring chinook fisheries to facilitate the live release of unmarked spring chinook. The study focused primarily on the feasibility of using small-mesh tangle nets and onboard recovery boxes to increase survival rates for released fish. Preliminary results were encouraging and may lead to modifications to the traditional commercial net fishery in 2002.

Yakima River Spring Chinook Fishery

The first chinook salmon fishing season on the Yakima River in 40 years occurred in the upper Yakima River in June, 2000. Prompted by the largest run of spring chinook to the Yakima Basin in 17 years, an eight-day season was open on four suc-



Anglers head for their favorite fishing holes at the start of the 2001 spring chinook fishery on the lower Columbia River.

cessive weekends beginning June 10-11 and ending July 1-2. Catches were limited, but the new fishery generated a great deal of interest among anglers in the area.

The limited 2000 fishery was followed in 2001 with a much more extensive fishery, which opened the middle reach of the Yakima River beginning April 21. This popular fishery closed May 29 after an estimated 1,918 adult and 105 jack chinook were harvested.

Icicle River Spring Chinook Fishery

Early in 2000 and again in 2001, the Columbia River Technical Advisory Committee (TAC) forecast a large return of spring chinook to Bonneville Dam. These predictions were confirmed by close observation of dam passage, prompting WDFW to open sport fisheries targeting hatchery spring chinook (Carson stock) returning to the Icicle River – a tributary of the Wenatchee River from May 15 to July 22, 2000 and again May 7 to July 15, 2001. Regulations during both years allowed the harvest of two salmon per day with a non-buoyant lure rule in effect to reduce potential snagging.

WDFW conducted creel surveys on the Icicle River in 2000 and 2001 to estimate angler effort and harvest of Carson stock spring chinook and to identify any negative effects on ESA-listed steelhead and upper Columbia River spring chinook. An estimated 5,039 anglers harvested 1,606 Carson Stock spring chinook in 2000. Scale samples and coded wire tags (CWT) indicated that all the chinook originated from the Leavenworth National Fish Hatchery. Results from the 2001 season have not been fully analyzed but results appear to be similar to those found in 2000.

Summer/Fall Fisheries

Lower Columbia River Fall Fisheries

Fall fisheries in the mainstem Columbia River have been limited by potential impacts to Snake River wild fall chinook. This stock was listed under the federal ESA in 1992, and only a small incidental harvest is allowed on this stock in other fisheries. Non-Indian and tribal fisheries must share the limited allowable takes of listed fish. Sport fisheries in 1999 and 2000 were closed early to hold harvest levels within ESA limitations and commercial fisheries had minimal catches of fall chinook while targeting coho and sturgeon.

Upper Columbia Summer Chinook Fishery

The upper Columbia summer chinook returns for 2000 and 2001 were estimated to be among the strongest returns in recent history, greatly exceeding hatchery and wild brood stock spawning needs. Since this stock is stable and NMFS found that a fishery was “not likely to have a negative impact to ESA listed fish,” WDFW opened a sport fishery for summer chinook returning to the Columbia River upstream of Priest Rapids Dam from August 10-October 31, 2000.

This fishery opened more than a month earlier than the traditional fishery for summer/fall chinook fishery above Priest Rapids Dam from September 16 through December 31. By moving the season forward, anglers were able to target healthy Upper Columbia River summer chinook stocks in 2000. The season was timed to start after the ESA-listed spring chinook cleared the mainstem Columbia River and prior to the arrival of most of the ESA-listed Upper Columbia steelhead.



As in most other state waters, salmon fishing in the Columbia River improved substantially during the 1999-01 Biennium.

Most angling effort in 2000 occurred in the river reaches below Wells and Rock Island dams and near the confluence of the Columbia and Wenatchee rivers, and in the forebay of Priest Rapids Dam. Throughout the summer chinook fishery, WDFW fish biologists, enforcement officers, and hatchery personnel conducted creel surveys designed to collect information on angler effort and harvest. Survey forms and signs requesting voluntary reporting by anglers on effort and catch were placed at each river access area.

Yakima River Fall Fishery

Fall fisheries in the Yakima River target hatchery returns of fall chinook and coho from releases by the Yakama Nation. In both 1999 and 2000, the Yakima River downstream of Prosser Dam was open for salmon fishing from late September through the end of October. Before 1998, this fishery had not been open since 1966. Catch data for 1999 indicates that 207 fall chinook were harvested in the lower Yakima River. Fishing effort in 2000 was nearly twice that estimated in 1999, resulting in an estimated harvest of 255 adult chinook, 22 jack chinook, 54 adult coho and 15 jack coho.

Salmon fisheries were also open from the I-82 bridge at Union Gap to 400 feet below Roza Dam from November 15 to December 31 in 1999 and again in 2000. Effort and harvest was very low in 1999, but increased slightly in 2000. Estimated harvest in the middle Yakima in 2000 was 36 adult chinook and 306 adult coho.

Hanford Reach Fall Chinook Fishery

The Hanford Reach fall chinook salmon run is the largest population of naturally spawning salmon in the state, supporting the largest salmon fishery in eastern Washington. Based on a creel survey of 5,824 boat and 235 bank anglers, WDFW estimated that 5,100 adult and 500 fall jack chinook were harvested during the fall 1999 Hanford Reach chinook sport fishery.

In 2000, anglers harvested an estimated 3,435 adult fall chinook and 676 fall jack chinook, based on survey of 2,360 boats and 396 bank anglers. This decrease in harvest between 1999 and 2000 could not be explained by escapement estimates – which were actually higher in 2000 – or by the number of angler trips in each year. Escapement estimates were 19,744 in 1999 and 19,845 in 2000. Angler trips were 29,812 in 1999 and 47,960 in 2000.

SALMON HATCHERIES

Hatcheries have operated in Washington state for more than a century, beginning with one hatchery on the Kalama River in 1895. Originally built to compensate for land use decisions that permanently altered large areas of fish-producing habitat, state hatcheries have since become an important part of the state's economy, releasing millions of fish annually for harvest by recreational and commercial fisheries. Tagging studies indicate that more than 75% of all coho and chinook salmon caught in state fisheries begin life in a hatchery facility, as do 88% of all steelhead.

The Washington Department of Fish and Wildlife (WDFW) now operates 91 hatchery facilities, of which 69 are dedicated to producing salmon and/or steelhead while the other 22 rear trout and other gamefish exclusively. (*See Freshwater Fish section of this report.*) Thirty-five tribal hatcheries and 12 federal hatcheries also contribute to the statewide salmon harvest, which contributed more than \$1 billion to the state's economy in 2000 according to estimates by the U.S. Department of Commerce.

In recent years, state hatcheries also have taken on a new, equally important role in helping to recover and conserve the state's naturally spawning salmon populations. Nearly a third of all state salmon hatcheries were involved in some aspect of wild salmon recovery during the 1999-01 Biennium, whether by rearing juveniles prior to release or holding fish through their lifespan to ensure the survival of depressed stocks. This renewed focus on wild stock recovery represents a major realignment in hatchery operations, as WDFW, the tribes, federal government and independent scientists worked to develop a comprehensive operations strategy for hatcheries in Washington.

One major milestone reached during the biennium was the mass-marking of virtually all hatchery coho salmon and nearly half of all hatchery chinook salmon released from state hatcheries. Using new, automatic fin-clipping machines, state hatchery crews marked more than 60 mil-

lion fish in each year for release from state and tribal hatcheries, allowing for easy identification of hatchery salmon on the fishing grounds. As discussed in the Salmon Harvest section of this report, mass-marking laid the foundation for a new era in selective fisheries in which fishers are required to release wild, unmarked fish.

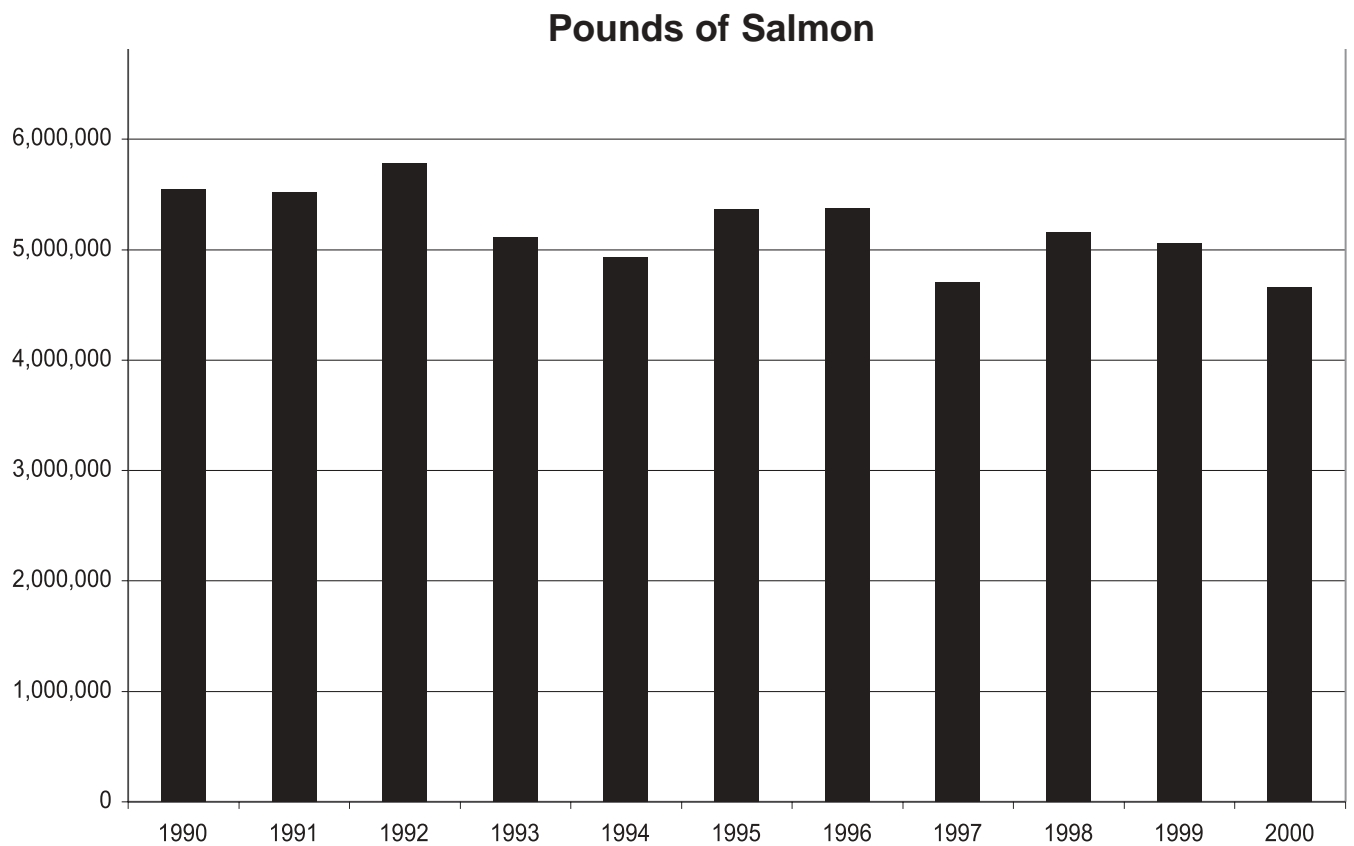
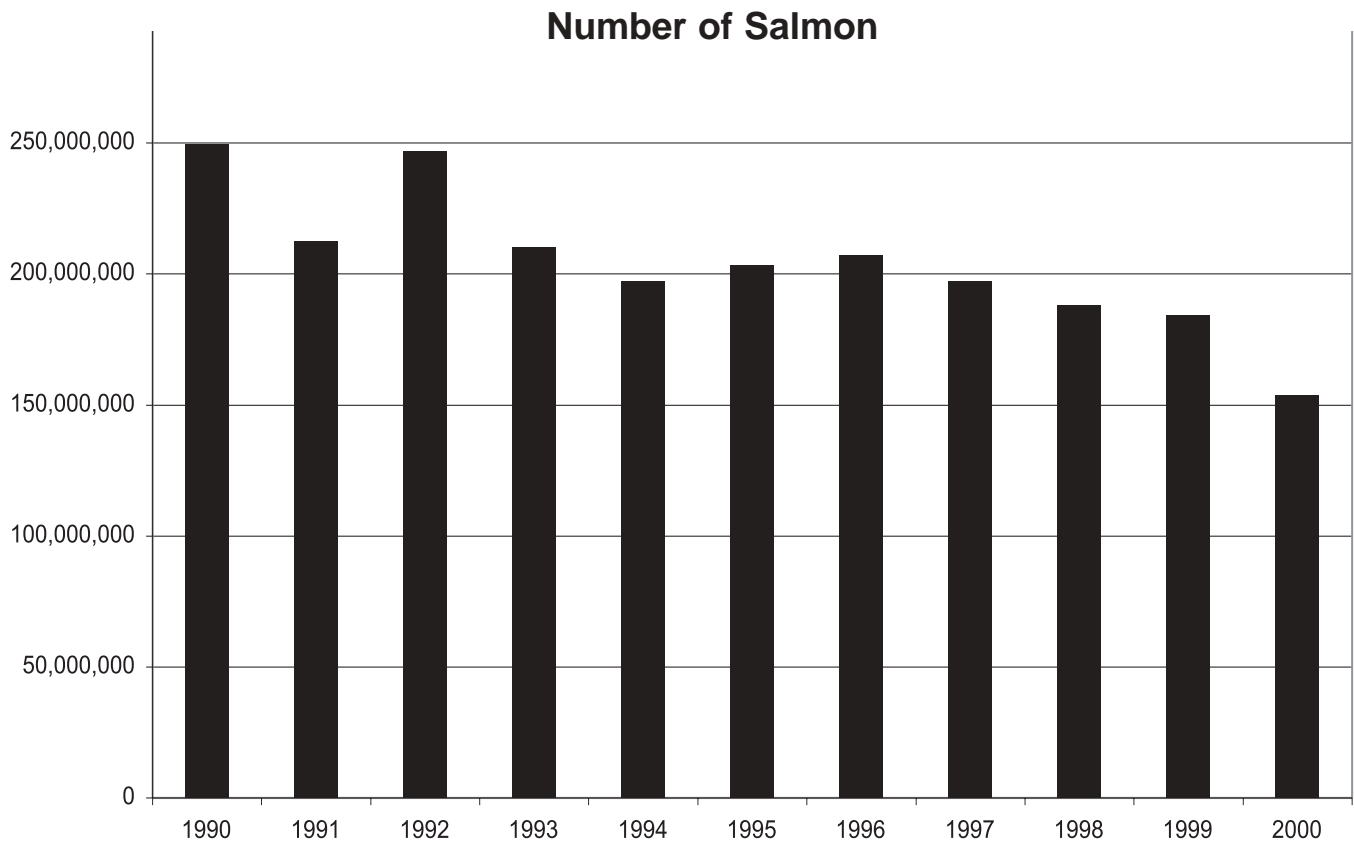
Like all activities that can affect wild stocks, state hatcheries have come under intense review since the listing of additional salmon population groupings under the ESA. In addition to initiating its own review process, WDFW worked with federal natural resource agencies and a newly appointed regional science panel to identify ways to minimize adverse impacts of hatchery operations on depressed wild stocks. These ongoing efforts, including the Department's new Benefit/Risk Assessment Procedure (BRAP) and the development of Hatchery and Genetic Management Plans (HGMPs) for more than one hundred state hatchery programs, are discussed in the Applied Salmon Research section of this report.

The Hatcheries Division is the largest single component of WDFW's Fish Program, with 340 FTE employees and a total operating budget of \$56.26 million during the 1999-01 Biennium, including \$17.3 million from the State General Fund. Working out of the Department's headquarters in Olympia and 17 regional complexes throughout the state, hatchery staff were responsible for fish culture, fish health, facility maintenance, hatcheries support (including activities ranging from tagging fish to securing permits) and administration.

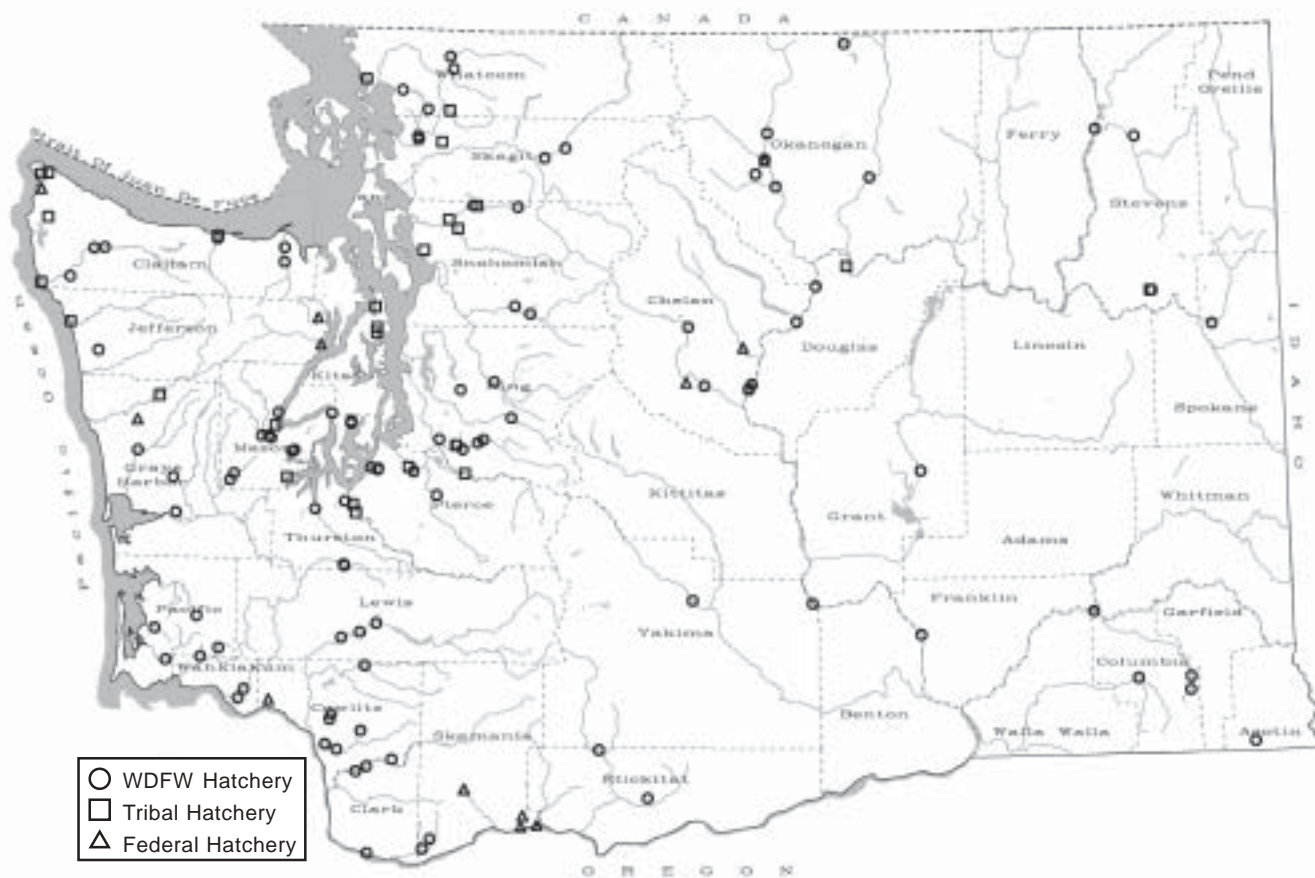


The Cowlitz Hatchery in southwest Washington is one of 91 hatchery facilities operated by WDFW. Together, these facilities represent a public investment of more than \$1 billion.

Total Salmon Production by State Hatcheries (All Species)



Hatcheries in Washington State



Hatchery Production

Hatchery production figures for 1999 and 2000 show a continuing decline in the number of juvenile salmon released from WDFW hatcheries in recent years. The decline in poundage is less pronounced, however, because fish have generally been held longer in recent years to improve their chance of survival once they are released. Returns of adult salmon should be maintained over time under this approach.

In either case, ESA-related permitting requirements have made it necessary to decrease production of specific stocks or species at certain locations. In other cases, poor ocean survival conditions reduced the number of adults returning to some hatcheries, reducing the availability of eggs. Finally, WDFW's hatchery budget has not kept pace with increasing

operating costs (especially utilities and labor costs), forcing cutbacks in some programs.

Returns of salmon to WDFW hatcheries during the 1999-01 Biennium showed typical annual variations by species and region. While hatchery return numbers offer some indication of the health of salmon stocks, it should be noted that hatchery returns can be strongly influenced by harvest rates and other factors. (Numbers have been rounded to the nearest 1,000 fish in the regional summaries that follow.)

Puget Sound

Some chinook stocks in Puget Sound showed important increases during 1999 and 2000, rebounding from their lowest return rates on record during the mid to late 1990s. Spring chinook, especially, showed increases of up to 50% in the number of adult salmon returning to key facilities, compared to 1997 and

Salmon Releases and Returns, 1999/2000

Adult returns, egg takes and subsequent releases from WDFW hatcheries

	Adult Return	Adults Upstream	Hatchery Egg Take	Egg Take Goal	Juvenile Fish ** Released
CHINOOK					
1999					
Puget Sound	80,306	9,629	46,751,443	50,715,000	42,497,830
Coast	5,917	175	5,634,500	14,665,000	6,969,816
Col. River	46,501	2,659	51,790,950	53,710,000	41,264,527
2000					
Puget Sound	56,273	10,357	47,846,515	52,365,000	36,924,619
Coast	10,466	27	10,102,400	13,165,000	4,978,489
Col. River	42,242	6,889	50,706,572	55,677,400	38,563,285
COHO					
1999					
Puget Sound	58,183	22,015	15,743,210	22,072,000	11,134,926
Coast	69,262	2,685	11,590,100	10,059,000	7,882,909
Col. River	125,019	57,990	27,462,278	18,205,000	22,466,539
2000					
Puget Sound	200,796	38,512	15,426,930	22,068,800	9,470,907
Coast	78,141	4,185	8,690,500	9,100,000	6,482,384
Col. River	211,223	90,449	22,698,168	23,415,000	16,751,542
CHUM					
1999					
Puget Sound	60,286	10,782	40,365,500	43,675,000	40,571,247
Coast	646	351	271,000	285,000	284,000
Col. River	581	433	212,681	195,000	108,711
2000					
Puget Sound	49,899	18,722	22,871,121	43,675,000	32,130,674
Coast	251	97	152,200	200,000	152,750
Col. River	272	18	190,000	190,000	197,481
SOCKEYE					
1999					
Puget Sound	6,251	745	3,090,000	20,380,000	11,024,495
Coast	None	--	--	--	--
Col. River	216	70	191,700	176,000	121,344
2000					
Puget Sound	37,446	20,844	17,171,000	20,380,000	5,051,417
Coast	3	1	None	None	--
Col. River	1,623	1,429	195,500	260,000	167,955
PINK					
1999					
Puget Sound	9,281	1,491	1,810,500	1,500,000	None
Coast	None				
Col. River	2	2	None	None	--
2000					
Puget Sound	--	--	--	--	1,632,390
Coast(Pink salmon return only in odd-numbered years)					
Col. River	--	--	--	--	--

** Tables include coop and Regional Fisheries Enhancement Projects, but do not include federal or tribal programs.

1998. These higher returns provided enough eggs to sustain recovery efforts at such hatchery facilities as Kendal Creek, Marblemount and Minter Creek, which rear chinook stocks listed under the ESA.

Fall chinook returns stayed consistent throughout the region during this time frame, averaging about 65,000 fish for all facilities. Hatcheries with large (and expected) fall chinook returns included Soos Creek, Samish and Minter Creek, all of which had average returns of 9,000-10,000 fish in 1999 and 5,000-7,000 fish in 2000.

Coho salmon returns displayed large annual variations in 1999 and 2000. Returns to the hatchery rack in 1997 and 1998 averaged 117,000 fish, then dropped sharply in 1999 to 58,000 adults before increasing to over 200,000 in 2000. Very strong returns were seen in 2000 at Soos Creek (43,000 fish), Voights Creek (41,000 fish) and Wallace River (23,000 fish).

Pacific Coast

Hatchery returns of fall chinook to coastal facilities remained consistent during the 1999-2000 time frame, averaging about 6,000 fish per year. Coho, however, showed significant increases after returns of 23,000 fish in 1997 and 40,000 in 1998. In both 1999 and 2000, the number of returning adults rose to approximately 65,000 fish.

Columbia River

As in Puget Sound, returns of spring chinook to Columbia River hatcheries were up somewhat from a



WDFW hatchery workers harvest chinook salmon eggs at the Issaquah Hatchery.

Blackmouth salmon extend Puget Sound anglers' season

The Puget Sound Recreational Fishing Enhancement Program (PSRFE) was created by the Washington Legislature in 1993 with the goal of improving recreational fishing opportunities in Puget Sound. During the 1999-01 Biennium, the program produced more than two million yearling chinook salmon for harvest in the Sound each year.

Unlike most other hatchery-reared salmon, yearling chinook salmon are held in freshwater facilities a full year beyond the time when they would normally migrate to sea. As a result, most of these fish remain inside Puget Sound once they are released, providing angling opportunities for immature chinook (blackmouth) during the fall, winter and spring months as well as augmenting the catch during the normal salmon-fishing season in summer. The 2001 spring release of yearling chinook salmon was the fourth consecutive year the program has successfully released over two million fish into Puget Sound, contributing to fisheries from Sekiu to Olympia.

Yearling chinook are produced by 12 state and private facilities from Olympia to Orcas Island, including Hood Canal. Funding for the production began in 1994 with a license surcharge of \$10 for anglers who fished for salmon in the Strait of Juan de Fuca, Hood Canal, the San Juan Islands and the rest of Puget Sound. Beginning in 1998, the Legislature changed the \$10 fee to a percentage of all fishing licences sold by the Department of Fish and Wildlife. The new percentage system, averaging about 10% of all licenses sold, produces about \$1.4 million per year to support the PSRFE Program.

During the 1999-01 Biennium, the PSRFE Program was also active in research to grow lingcod in captivity. Through a partnership with the National Marine Fisheries Service at Manchester, the program has successfully grown lingcod from an egg stage to early adult life history. The PSRFE Program, in concert with directives in the original legislation, continues to support recovery of several Puget Sound bottomfish species.

very poor showing in the late 1990s. Returns in 1999 were about 12,000 fish and 10,000 in 2000, compared to just 7,000 fish in 1998. While low by historical standards, this increase was good news, because all of these stocks are listed under ESA.

Fall chinook returns were stronger than those for spring chinook, but still showed the decreasing trend of the late 1990s. In 1997, 31,000 fish returned to Columbia River hatcheries, followed by 34,000 in 1998. In 1999, returns increased to 41,000 fish before dropping to 22,000 fish in 2000. The Priest Rapids Hatchery continues to have the strongest returns of fall chinook on the Columbia River, with returns of 15,000 fish in 1998, 23,000 in 1999 and 7,000 in 2000.

Coho salmon returns to Columbia River hatcheries increased from 47,000 fish in 1997 to 58,000 fish in 1998, then to 102,000 fish in 1999 and 184,000 fish in 2000. The largest returns in the last two years were seen at Cowlitz Salmon Hatchery (34,000 fish in 1999 and 41,000 in 2000) and Lewis River Hatchery (32,000 fish in 1999 and 61,000 in 2000).

Wild Stock Restoration

During the past two decades, the number of state hatcheries involved in some aspect of wild salmon recovery has increased from two to 21. Hatcheries are now viewed by fishery scientists and policy makers as integral tools for the restoration of wild runs that have dwindled because of habitat degradation or other factors. Fifteen of the 18 stocks included in recovery actions during the 1999-01 Biennium were listed under the ESA.

Hatcheries play several different roles in sustaining wild stocks. For stocks such as Methow River summer chinook and dungeness River pink salmon (fall run), adults are captured and spawned each year and the resulting progeny are reared and released as juveniles. The purpose of these efforts, called "supplementation," is to maximize egg fertilization and fry survival and thereby increase the number of outmigrating smolts.

For other stocks, such as Dungeness spring chinook and White River spring chinook that are at dangerously low population levels, juveniles were main-

Volunteer programs also raise millions of salmon and trout

While most hatchery-raised fish begin life at state, federal or tribal facilities, volunteer programs typically account for nearly 10% of all salmon released into state waters each year.

During the 1999-01 Biennium, WDFW worked with school districts, volunteer organizations and individuals on more than 1,000 projects designed to help restore depressed salmon runs and to produce fish for harvest. In all, these projects – ranging from backyard egg boxes to large-scale net pens – produced an estimated 15 million juvenile salmon in each year of the biennium.

More than 1.5 million catchable-size trout were also produced each year by 39 volunteer projects supported by WDFW.

Major participants included classrooms involved in the agency's Salmon in the Classroom Program, the state's 14 Regional Fisheries Enhancement Groups (RFEG), members of the Volunteer Cooperative Program, Trout Unlimited and many other organizations and individuals. For more information on these efforts, see the Public Outreach section of this report.

tained in a hatchery for their entire life to ensure the stock's survival – a practice known as "captive brood." While this process can often take years to show results, efforts by WDFW to bolster depleted runs paid off at a number of facilities during the 1999-01 Biennium.

The captive brood program for Dungeness spring chinook is a prime example. Starting in 1992, approximately 2,000 wild juvenile salmon were captured each year for five years and held at three facilities: the Hurd Creek and Dungeness hatcheries and the South Sound Net Pens. Since then, the number of outmigrating smolts was increased from an estimated 20,000 to 30,000 naturally produced smolts per year to more than 1,000,000 in 1997-2000.

Wild Stock Restoration Projects

Currently, restoration efforts are taking place on the following stocks.

(* = Type of restoration efforts; Both = captive brood and supplementation.)

Species/Stock	County	ESA listed/year	Type*
Spring Chinook			
White River (Puyallup system)	Pierce	Yes/1999	Both
Wenatchee River	Kittitas	Yes/1998	Supplementation
Tucannon River	Columbia	Yes/1992	Both
Nooksack River	Whatcom	Yes/1999	Supplementation
Skagit River	Skagit	Yes/1999	Supplementation
Chiwawa River	Chelan	Yes/1998	Supplementation
Twisp River	Okanogan	Yes/1998	Both
Chewuch River	Okanogan	Yes/1998	Supplementation
White River (Wenatchee system)	Chelan	Yes/1998	Captive Brood
Dungeness River	Clallam	Yes/1999	Captive Brood
Fall Chinook			
Snake River	Columbia	Yes/1992	Supplementation
Summer Chinook			
Methow River	Okanogan	Yes/1998	Supplementation
Similkameen River	Okanogan	Yes/1998	Supplementation
Skykomish River	Snohomish	Yes/1999	Supplementation
Summer Chum			
Salmon Creek	Clallam	Yes/1999	Supplementation
Sockeye Salmon			
Lake Wenatchee	Chelan	No	Supplementation
Cedar River (Lake Washington)	King	No	Supplementation
Pink Salmon			
Dungeness River (Fall run)	Clallam	No	Supplementation

The resulting adult returns from the project increased from an average of 167 fish from 1986 to 1999 to 218 in 2000 and 453 in 2001 – the highest number since surveys began in 1986. WDFW's partners in the project included the Jamestown S'Klallam Tribe, the Olympic National Park, NMFS, the U. S. Forest Service and volunteers from Olympic Outdoor Sportsmen's Association, Wild Olympic Salmon and the North Olympic Salmon Coalition.

The White River chinook salmon restoration project on the Puyallup River system is the oldest recovery effort involving hatchery facilities in Washington, setting the standard for similar efforts up and down the West Coast. Begun in the late 1970s by the former Washington Department of Fisheries and still con-

tinuing, this project has used supplementation, captive brood, habitat restoration and harvest restrictions – as well as dam relicensing and water withdrawal agreements – to bring this unique stock back from the brink of extinction.

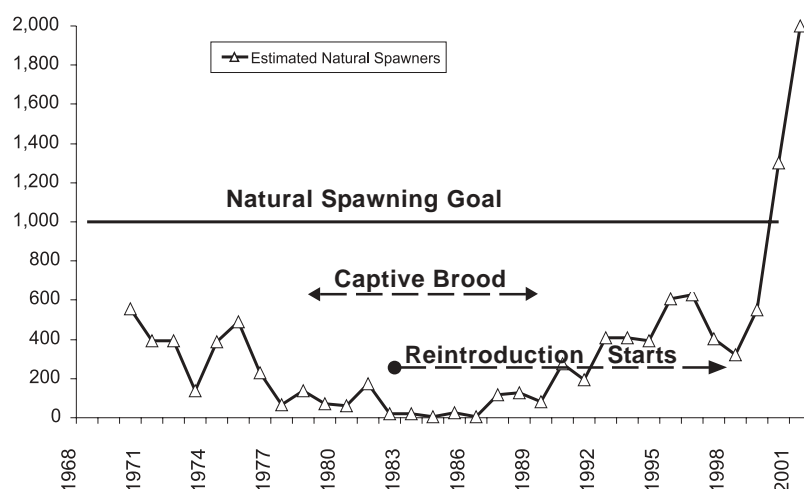
Working in cooperation with the Puyallup Tribe, the Muckleshoot Tribe, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service and NMFS, WDFW has helped to build the White River chinook salmon population – listed as “threatened” under the ESA in 1999 – from fewer than 20 returning adults in the early 1980s to 553 adult returns in 1999 and an estimated 2,000 fish in 2001. Prospects for recovery of this stock are now considered good and the project has become a model for successful stock restoration.

Hatchery facilities involved include Hupp Springs, Minter Creek, South Sound Net Pens, the Muckleshoot Tribal Hatchery on the White River and a number of rearing ponds provided by the Puyallup Tribe.

In addition to supplementation and captive brood recovery projects, WDFW used its hatchery facilities to protect and nurture wild salmon runs in other ways during the 1999-01 Biennium:

- **Mass Marking:** Perhaps the single biggest change in salmon fishing during the last biennium was the expansion of selective coho fisheries to include the Washington coast and many inland waters. To make it possible for fishers to distinguish between hatchery and wild coho, WDFW crews started clipping the adipose fins of hatchery coho in 1996, including nearly all of those produced in the 1999-01 Biennium. It also allowed fisheries managers to better assess hatchery/wild stock composition in various fisheries as well as stray rates into natural spawning areas. Significant selective fisheries were allowed in 1999 and again in 2000 (from juveniles clipped in 1997 and 1998), protecting wild stocks, while providing for the harvest of healthy hatchery runs.
- **Nutrient Enhancement:** Research over the past decade in Washington, British Columbia and Alaska has demonstrated the critical role salmon play in transporting nutrients from the Pacific Ocean to aquatic and terrestrial ecosystems of the Pacific Northwest. The Hatcheries Division worked aggressively with Regional Fishery En-

White River Spring Chinook Recovery



hancement Groups and other local organizations, primarily volunteers, to distribute the carcasses of adult salmonids used for broodstock at WDFW hatcheries back into watersheds. Beginning in 1996 with 14 projects and 4,747 carcasses, the program grew to include 123 projects that distributed more than 160,000 carcasses into streams across the state in 2000. These projects range in size from 20 carcasses for Barnaby Slough (Skagit watershed) to 10,000 carcasses into the Kalama River. Additional projects were approved for 2001, when more than 200,000 carcasses were expected to be distributed. Because the movement of fresh carcasses between watersheds has limitations due to the risk of spreading fish pathogens, WDFW has taken a leadership role in international conferences dealing with the development of approved alternatives such as processed carcasses (pasturized briquettes) or fertilizers to replace the lack of nutrients in streams with poor adult returns.

Mass-Marked Salmon Releases by WDFW Hatcheries

	1999		2000		2001*	
	Coho	Chinook	Coho	Chinook	Coho	Chinook
Puget Sound	7,641,334	14,004,541	8,025,442	20,407,326	7,172,626	22,445,581
Coastal	5,285,547	214,814	5,320,454	0	5,917,231	0
Columbia River	14,562,276	10,602,371	14,865,831	8,493,294	10,719,190	9,616,046
Totals	27,489,157	24,821,726	28,211,727	28,900,620	23,809,047	32,061,627

* 2001 release data preliminary

Hatchery Infrastructure

With the listing of large numbers of naturally produced salmon populations under the ESA, all the factors believed to play a role in the decline of a stock became subject to review, including state hatcheries. While hatcheries have become an increasingly important tool in the restoration of wild stocks, they can also present obstacles to recovery.

Some facilities, particularly those built decades ago, can present physical barriers to naturally produced outmigrating juveniles or adult fish returning to streams to spawn. Scientists also have concerns about interbreeding between wild and hatchery fish, and about predation and competition for food in streams, estuaries and the open ocean. As discussed in the Applied Salmon Research section of this report, WDFW worked to address these issues in a variety of ways during the 1999-01 Biennium, filing 128 Hatchery and Genetic Management Plans (HGMPs) with NMFS and developing a Benefit/Risk Assessment Procedure (BRAP) to help analyze the compatibility of each state hatchery with the goal of recovering wild salmon stocks.

For all these efforts, the need for additional investments in the state's aging hatchery infrastructure was identified long before the announcement of the latest round of ESA listings in 1999. In 1991, a study by the consulting firm of Dan Adkins and Associates found that most state salmon hatcheries had entered the last quarter of their expected design life and would require major renovations and repair. Based on a review of just 35% of the facilities operated by the former Department of Fisheries, the study indicated that at least \$25.3 million would be needed to meet immediate needs at those facilities alone.

Since then, funding for hatchery facilities has fallen significantly short of the amount needed to meet those basic operational needs, let alone address all the new issues raised by the ESA. From 1993 through 1997, state capital funding averaged \$5.2 million per biennium, then rose to \$7.2 million in the 1999-01 Biennium and dropped to \$2.2 million proposed for 2001-03. WDFW also allocated \$2.4 million in operating funds for hatchery maintenance and repairs in the 1997-99 Biennium, but was forced to reduce that amount to \$1.3 million in 1999-01 and to \$770,000 proposed for 2001-03 to meet other priorities.

New legislation: Salmon carcasses and aquaculture

The Washington State Legislature approved two pieces of legislation during the 1999-01 Biennium that have a direct bearing on hatchery operations.

- **Salmon Eggs (ESHB 1286):** The bill, titled "An Act Relating To the Use of Viable Salmon Eggs," prohibits WDFW from destroying salmon that originated from a hatchery for the purpose of destroying viable salmon eggs that would otherwise be useful for replenishing fish runs as determined by the department and Indian tribes with treaty fishing rights.

The new law also specifies a prioritized order for distribution of salmon eggs, and directs the Department to allow more hatchery-produced salmon to spawn naturally in areas where progeny of hatchery fish have spawned before. The Department is drafting rules consistent with this legislation and will produce annual reports on the disposition of salmon eggs and carcasses.

- **Aquaculture (SSHB 1499):** Titled "An Act Relating to the Regulation of Marine Fin Fish Aquaculture," the bill returns regulatory authority to the Department over marine fin fish aquaculture. The Department, with the Hatcheries Division acting as lead, is in the process of drafting rules as directed by the bill covering areas of escape prevention, rapid recapture protocols and approval procedures for the species, stock and race of marine fish to be reared. It is also establishing an Atlantic Salmon Watch Program similar to that currently existing in British Columbia. Draft rules were prepared for the 2002 Legislature.

Faced with difficult choices, WDFW prioritized its capital funding to focus on projects that reduce hatchery impacts on wild fish. The final phase of a major renovation project at Issaquah Hatchery was begun

with provisoed funds, but needed screening and fish-passage work was delayed at the Minter Creek Hatchery and a number of other facilities. To fund renovation of incubation facilities at the Marblemount Hatchery, the Department secured \$285,000 from the Seattle Public Utility District in 2001.

WDFW regularly monitors the discharge from all hatcheries to comply with federal water quality standards. However, a number of state facilities did not comply with these standards during the biennium, due to insufficient funding for needed renovations.

The state's hatchery system represents a public investment of approximately \$1 billion. Built as compensation for lost natural habitat, state hatcheries produce millions of fish for harvest every year, supporting fisheries and local economies from northern Puget Sound to the Columbia River. For an increasing number of depressed wild stocks, hatchery programs offer the best chance of survival. During the 1999-01 Biennium, WDFW worked to protect the public's investment in state hatcheries and make the changes necessary to ensure they will continue to provide these benefits in the 21st century.

NATURALLY SPAWNING SALMON RUNS

The long-term decline of Washington's naturally spawning salmon populations was cast into the public spotlight in 1999 when they were listed for pro-



Of the 294 naturally spawning salmon stocks identified in the Salmonid Stock Inventory (SaSI), 151 were classified as "healthy," 78 as "depressed," 11 as "critical," one as "recently extinct" and 53 as "unknown."

tection under the federal ESA in seven additional regions of the state – including Puget Sound. Although many wild stocks had been declining since the early part of the 20th century, the new listings demonstrated both the risks to wild salmon and the sacrifices necessary to provide for their recovery.

For the Washington Department of Fish and Wildlife (WDFW) and other resource managers, no other single issue has commanded so much attention in recent years as the protection and recovery of Washington's native salmon populations. Habitat restoration, selective fisheries, supplementation programs at hatcheries – these and other efforts to protect and restore wild salmon runs are discussed in various sections of this report. (See Habitat, Salmon Harvest and Hatcheries.) The focus of this section of the report is on the wild stocks themselves.

There are six indigenous species of Pacific salmon (*oncorhynchus*) in Washington state, including chinook, coho, chum, pink and sockeye. (Steelhead are also a member of the *oncorhynchus* family, but have a different spawning history and are discussed in the Freshwater section of this report.) Salmon of the same species returning to discrete spawning areas, known collectively as a "stock," have genetic and behavioral characteristics that distinguish them from stocks returning to other spawning areas. This genetic diversity – a result of natural selection – is one of the primary differences between wild salmon and the more genetically homogenous hatchery fish.

Naturally spawning salmon that are genetically adapted to their environment have several advantages over introduced stocks: They are generally more productive, more resilient to environmental changes and exhibit a broader range of individual characteristics, such as run timing, age at return and adult size. Although hatcheries have succeeded in their primary purpose of supplementing naturally spawning salmon runs and providing additional salmon for harvest, hatchery fish are not a substitute for naturally spawning stocks which are better adapted to survival in the wild.

In 1993, a total of 438 salmon and steelhead stocks indigenous to state waters were identified through a joint effort by the Washington Department of Fisheries, the Washington Department of Wildlife and western Washington treaty tribes. Of the 294 salmon stocks identified, 151 were classified as "healthy,"

78 as “depressed,” 11 as “critical,” one as “recently extinct” and 53 as “unknown.” The Salmonid Stock Inventory (SaSI), as it is now known, also evaluated the status of 144 steelhead stocks, and has since been amended to include assessments of bull trout, Dolly Varden and cutthroat trout stocks. (See Freshwater Fish section of this report.) WDFW worked throughout the 1999-01 Biennium to complete an update on all stocks, scheduled for release in 2002.

This type of assessment presents a major challenge, since the long-term condition of a stock cannot be determined by simply comparing the number of fish returning in one time period to another. Ocean conditions, flooding, drought and a variety of other factors can cause major fluctuations in the number of salmon returning in any given year – and even for a decade or more. For that reason, the fact that most stocks – both wild and hatchery – returned in greater numbers each year from 1999 through 2001 should not be interpreted to mean that all these populations are on the road to recovery.

Returns of naturally spawning salmon in 1999 and 2000 are summarized below and on the next page by species and by area. Estimates of total run size include both the number of fish returning to their spawning grounds (“escapement”) and those caught in various recreational, commercial and tribal fisheries. While salmon harvested in fisheries are documented in catch reports, WDFW draws on a variety of data – including stream counts, weir counts, fishway counts and tag recoveries – to determine the annual escapement. As part of this process, 7,000 miles of spawning grounds are visually surveyed each year by WDFW staff to determine the number of naturally spawning salmon returning to certain stream areas. These estimates provide a baseline for managing the resource from year to year, and also serve as a starting point for assessing the long-term condition of individual stocks.

Puget Sound

All but one of the five salmon species that spawn in the Puget Sound area returned in relatively low numbers in 1999 and 2000. Returns of Puget Sound chinook salmon dropped sharply in 1999, then picked

SaSI Stock Status Classifications by Species

Ratings done in 1992-93, with update for bull trout, Dolly Varden, coastal cutthroat.

	Healthy	Depressed	Critical	Unknown	Extinct	Total
Chinook	54	35	5	14	0	108
Chum	48	3	2	18	1	72
Coho	37	34	1	18	0	90
Pink	9	2	2	2	0	15
Sockeye	3	4	1	1	0	9
Steelhead	36	44	1	60	0	144
Bull Trout/ Dolly Varden	14	2	6	58	0	80
Coastal Cutthroat	1	7	0	32	0	40
Total	202	131	18	203	1	555

up the following year. This annual variation can largely be attributed to environmental factors, which have little bearing on the long-term decline of naturally spawning chinook stocks listed in 1999 as “threatened” under the ESA. Adverse freshwater and marine conditions also appear to be the primary cause of low returns of coho, chum and pink salmon in many areas of Puget Sound, although this appears to be due largely to a cyclical phenomenon rather than a sign of long-term decline.

Wild coho in south Puget Sound are a particular concern, because marine survival rates and run sizes have been chronically depressed since the mid-1990s. The strong sockeye return to Lake Washington in 2000 was a bright spot in Puget Sound salmon runs during the 1999-01 Biennium.

Chinook Salmon

There are 17 indigenous populations of chinook salmon in the Puget Sound area, all of which have been in decline for more than three decades. In 1999, amid growing concern about the long-term viability of these stocks, the National Marine Fisheries Service (NMFS) listed all naturally spawning stocks as a single “threatened” Evolutionarily Significant Unit

(ESU) under the ESA. Ongoing efforts to restore these stocks have led to major changes in harvest management, habitat stewardship, timber practices and other activities discussed in this report.

The long-term decline in naturally spawning stocks is not readily apparent from estimates of total chinook salmon runs to Puget Sound over the past three decades. Supported by steady production of hatchery salmon, total annual returns fluctuated between 100,000 and 200,000 adults from 1968 through 2000, depending on environmental conditions and other factors. The main change during that time was the abundance of wild chinook, which declined from 30% to 50% of the annual run in the late 1960s through the 1970s to between 20% to 30% since the early 1990s.

The abundance of wild chinook salmon in Puget Sound dropped sharply in 1999, after extreme flooding in the 1995 brood year. The 1999 run of 13,892 fish was only half the size of the previous year, although returns of wild chinook increased to 29,060 fish in 2000 and 29,622 fish in 2001. As with most other salmon species, improvements in those years were most likely due to favorable freshwater and ocean conditions, although changing harvest practices have also reduced the incidental “take” of wild chinook salmon.

While fishing pressure on Puget Sound chinook stocks has been significantly reduced over the past decade, wild populations still face continued loss of habitat suitable for spawning and rearing. Continuing growth in the human population, and the demands

it puts on the region’s natural resources, remain the greatest challenge to naturally spawning chinook populations in the Puget Sound area.

Coho Salmon

In 1999, record low returns of both wild and hatchery coho populations occurred throughout western Washington, southern British Columbia, and Oregon. Puget Sound coho populations were no exception. The decline in survival rates was particularly acute for South Puget Sound origin stocks, as evidenced by the less than 1% marine survival observed for the Deschutes River wild coho indicator stock in 1999. By comparison, approximately 20 % of Deschutes River wild coho returned in the 1983-92 return year period, followed by a survival rate of 4.4% in 1994-98.

The Voights Creek hatchery on the Puyallup River also reported a marine survival rate for coho of about 1%, and the Minter Cr. Hatchery, a major South Sound coho production facility, failed to meet escapement needs that year. North Sound coho marine survival rates, while low, did not experience the same precipitous decline in this period as the South and Central Puget Sound stocks.

A pilot study to identify the causes of the particularly poor return rates of coho to South Puget Sound in the late 1990s was conducted in 2000 by a multi-agency panel from WDFW, the Northwest Indian Fisheries Commission, the state Department of Ecology and other organizations. (*Fishing For Answers: Analysis of ecosystem dynamics, trophic shifts, and salmonid populations in South Puget Sound, WA, 1970-1999*). Preliminary findings suggest that abnormally poor production at the base of the regional food web and strong competition for food between naturally spawning coho and hatchery fish were major factors in this decline in returns.

Total run size estimates for Washington coho are not yet available for the 1999-2001 time period, due to their heavy contribution to mixed-stock fisheries. However, information from coded wire tags does provide an indication of wild stock spawning escapement and marine survival on a regional basis for those years.

- **South Puget Sound:** The escapement of naturally spawning fish for this region was at a record low level in 1999, largely a reflection of the record low marine survivals observed for South



Smolt traps like these are a common sight on the Skagit River, where WDFW has used them to measure freshwater production of juvenile salmon since 1990.

Sound hatchery and wild origin coho in this time period. Escapements rebounded significantly in 2000. Recent sampling by WDFW has confirmed a significant portion of the natural South Puget Sound coho escapement consists of hatchery-origin fish from extensive net pen projects and other hatchery programs in the region, so natural spawning trends in this region are heavily influenced by hatchery origin coho abundance. South Puget Sound is currently primarily managed for hatchery coho production.

- **North Puget Sound:** The combined natural escapement to the major north Puget Sound river basins that are actively managed for wild coho (Skagit, Stillaguamish, and Snohomish River basins) was slightly below the aggregate escapement goal in 1999. There was a considerable improvement in the total escapement levels in the year 2000, as occurred elsewhere in Washington. Marine survival rates for these stocks, although low to moderate in relationship to historical levels, did not reach the critically low levels observed in South Puget Sound stocks. As with other Washington coho stocks, it is important to note that greatly reduced Canadian and other mixed-stock coho fisheries in the mid to late 1990s have resulted in much lower harvest rates for most Washington coho stocks.
- **Strait of Juan de Fuca and Hood Canal:** Although the 1999 escapement of Hood Canal naturally spawning coho was below the 21,500 goal, the 2000 escapement of 26,500 fish exceeded that goal. Similarly, the natural escapement to Strait of Juan de Fuca streams fell short of the 12,800-fish goal in 1999, but exceeded it in 2000 with an escapement of 19,000 fish.

Chum Salmon

Puget Sound fall chum salmon have been extremely successful over the last two decades. In the 21-year span between 1978 and 1998, Puget Sound wild chum runs exceeded 1 million fish 11 times, peaking in 1994 at just under 1.8 million fish. For this same period, Puget Sound wild chum escapements averaged 141,900 fish, and total wild run sizes averaged 838,000 chum. These levels compare favorably with past run sizes, and a 1997 chum salmon review conducted by NMFS concluded that Puget Sound chum salmon were “at or near historic levels.”

However, because of recent changes in conditions in the north Pacific Ocean, local chum salmon runs were significantly lower in 1999 and 2000 than the exceptional returns of the last two decades. Averaging 458,600 fish each year, returns in 1999 and 2000 may represent a shift to a period of lower overall productivity for this species. This decline in run size may relate to a recent drop in sea surface temperatures and food production in the region of the north Pacific Ocean used by chum salmon during their ocean life. This shift in ocean conditions and the relationship with changing chum salmon production follows a long term pattern (back to the early 1900s) of decadal length variation.

Accordingly, this recent contraction in Puget Sound chum salmon run sizes can be considered to be a normal part of the long term cyclic abundance of regional stocks, and should not be viewed as a decline to a depressed status. In fact, chum returns were generally very strong in 2001, breaking the pattern of the previous two years.

Summer chum salmon stocks in the Hood Canal and Strait of Juan de Fuca region are a separate issue – and a matter of continuing concern for WDFW and tribal co-managers. During the 1980s, summer chum returns declined from tens of thousands to an all time low of less than 800 spawners in 1990. In March of 1999, NMFS listed these summer chum as a threatened species under the ESA. Since 1992, WDFW has worked with the Point No Point Treaty Tribes, USFWS and NMFS to restore these stocks, with gradual success. Summer chum returns to Hood Canal were 4,526 fish in 1999 and 9,389 fish in 2000. Returns to Strait of Juan de Fuca were 577 fish in 1999 and 986 fish in 2000. While over 90% of these stocks now escape to spawn, some individual populations are still experiencing very small run sizes and escapements.

Pink Salmon

The pink salmon of Puget Sound are the southernmost stocks of this species in North America. They are abundant in most of the region’s larger streams on odd-numbered years (e.g., 1999 and 2001), and are represented by a single, small population (Snohomish River) during even-numbered years.

Puget Sound pink salmon are almost entirely naturally spawning fish, with small hatchery programs in Hood Canal and on the Dungeness River. Like



Sockeye salmon spawn naturally in two Washington lakes: Baker Lake and Lake Washington. The latter had a banner run in 2000.

chum salmon, the region's pink salmon have been abundant since the mid-1970s. For the 12 odd-numbered years between 1977 and 1999, five returns were over one million fish, and for one year (1995) returns exceeded two million pink salmon. During these same years, Puget Sound wild pink salmon escapements averaged 846,500 fish, and total wild run sizes averaged 1,197,400 pinks. These run sizes compare favorably with past returns, and a 1996 NMFS coast-wide review concluded that Puget Sound odd-year pink salmon were "close to historic levels."

The 1997 and 1999 returns of Puget Sound wild pink salmon averaged 658,800 fish, and may represent a drop to a lower overall productivity range for this species. This decline in run size, if it continues, is most likely related to the changes in the rearing conditions in the north Pacific discussed above for chum salmon. As with Puget Sound chum salmon, these changes should be considered to be a normal part of the pattern of cyclic abundance of local pink salmon stocks, and should not be viewed as a change in population status.

Sockeye Salmon

Two watersheds in the Puget Sound region support sockeye salmon populations: the Baker River (Skagit basin) and Lake Washington.

The Baker sockeye population is heavily influenced by the operation of two hydroelectric dams on the river, and as a result, spawning and egg incubation occurs in an artificial spawning beach. This run has had a variable production history, however, over the last ten years Baker sockeye have returned in good numbers (an average of 6,325 fish). Returns in 1999 and 2000 were 4,654 and 4,942 sockeye respectively.

Lake Washington sockeye display great variability in annual run sizes, in large part caused by winter flooding levels on the Cedar River. In years of extreme flooding, streambed erosion causes excessive losses of incubating sockeye eggs and alevins, resulting in poor production and run sizes four years later. The 1999 return was very poor, most likely as a result of severe flooding during the winter of 1995. This particular sockeye run has developed a pattern of large runs every four years, including one in 2000 with an estimated return of 460,000 fish. Thousands of anglers and tribal fishers participated in a successful fishery that year.

Washington Coast

Most coastal salmon populations met escapement goals in 1999 and 2000, although run strengths varied widely for each river and bay. Wild coho escapements have clearly improved since the mid-1990s, under new harvest restrictions imposed on U.S. and Canadian fishers. Ozette River sockeye, listed under the ESA as a "threatened" population, have also gained strength through active recovery efforts by the Makah Tribe.

Coastal Chinook

Coastal chinook include 10 major natural stock groupings returning to the Quillayute, Hoh and Queets rivers, as well as to Grays Harbor and Willapa Bay. These stocks include both spring/summer and fall run timings. While coastal chinook stocks are not listed under ESA, management of these stocks has been directed at achieving minimum escapement goals. Historical trends have exhibited wide fluctuations. After high abundance levels in the late 1980s, run sizes fell to more "normal" levels throughout the 1990s.

Coho Salmon

Natural coho escapement for all major wild populations on the north coast of Washington (Quillayute, Hoh, and Queets Rivers) were within the established goals or higher in 1999 and 2000. Escapement levels have been relatively high since the mid-1990s, due in part to reductions in Canadian interceptions and increased restrictions on U.S. fisheries designed to meet conservation needs for various wild stocks. The Grays Harbor combined natural coho escapement was below its goal in 1999

and 2000, while Willapa Bay was near goal in 1999 and above its goal in 2000.

Chum Salmon

The major coastal river systems all support wild chum salmon populations, although relative abundance levels vary widely. Chum returns to north coast streams (north of Grays Harbor) range from medium runs of a few thousand fish to very small runs of less than 100. Because of these small run sizes, no efforts are made to enumerate the populations north of Grays Harbor. Chum returns to the south coast were strong through the 1980s and early 1990s, but have declined in recent years. Run sizes for Grays Harbor chum salmon were below average in 1999 and 2000, with returns of 15,200 and 10,400 fish, respectively. Willapa Bay chum showed somewhat better performance in 1999 and 2000, with run sizes of 26,400 and 47,000 fish. As with Puget Sound chum, these shifts in abundance may be related to long-term climate changes.

Sockeye Salmon

Three stocks of sockeye salmon originate from Washington coastal watersheds. The Ozette and Quillayute stocks are very small, averaging less than 2,000 returning fish per year. The Ozette sockeye, which are listed under the ESA as a “threatened” population, have increased in recent years as a result of active recovery efforts by the Makah Tribe. Returns in 1999 and 2000 were 2,076 and 4,399 fish, respectively. The remaining coastal sockeye run returns to the Quinault system. Quinault sockeye returns over the last ten years from 1991 to 2000 have averaged 36,700 fish, but in 1999 and 2000 were substantially below average at 7,236 and 18,415 sockeye, respectively.

Columbia River

Most Columbia River salmon populations benefited from improving ocean and freshwater conditions in 2000 and 2001 – some spectacularly so. Fall chinook populations jumped to 1.3 million fish in 2001, while coho returns to the Yakima River were strong enough to permit the first coho fishery on that river in decades. Wild coho populations on the lower Columbia River also showed improvement, although the stock is still being considered for listing under the ESA.

Chinook Salmon

Columbia River chinook include 47 managed natural spawning stocks. Major groupings are distinguished by spawning areas and entry timing, returning in spring, summer and fall. Upriver “brights” are a component of the fall run, with a database that began in 1980. With the exception of large returns of fall chinook in the mid-1980s, abundance has been relatively stable for all stocks, with total abundance normally ranging from 500,000 to 700,000 adults. Returns jumped to 1.3 million chinook in 2001, due primarily to favorable ocean conditions.

This recent increased abundance should not diminish the concern for ESA listed fish and the continued trend of lower natural production. Mainstem and tributary dams have eliminated access to historic habitat and reduced survival of migrating juveniles and adults. Past hatchery practices of cross-basin transfers and mitigation efforts have also genetically homogenized many stocks. Today there are very few genetically distinct chinook populations, and many natural spawning chinook are first-generation hatchery chinook. Self-sustaining, native populations are rare in lower and mid-Columbia waters and non-existent in upper Columbia and Snake River.

On the Yakima River, a major tributary to the Columbia, spring chinook runs rebounded in 2000 and 2001 with the two largest runs in recent history. After dropping to a near-record low in 1995, spring chinook populations benefitted from a combination of high ocean survival and good freshwater flow conditions, generating very strong runs in the 1999-01 Biennium.

Coho Salmon

Most coho returns to the Columbia basin currently are from hatchery production. The majority of this production originates below Bonneville Dam, although there are small to moderate hatchery programs in the mid-Columbia Basin to meet in-river treaty fishery needs and other objectives. There is some natural production remaining in the basin, originating largely from lower river tributaries. The extent of natural production in this region, and its relationship to the hatchery populations, is under review.

Chum Salmon

The chum salmon of the lower Columbia River have been depressed since a population decline in the 1950s. Only two small populations remain: one stock

in Grays River and a second stock using several small streams just downstream of Bonneville Dam. The average run size for Columbia River chum from 1991 to 2000 was 2,520 fish. Returns in 1999 and 2000 were of average magnitude, with 2,400 and 2,500 chum salmon respectively.

Sockeye Salmon

The Columbia River Basin supports three sockeye populations: the Snake, Wenatchee and Okanogan river stocks. Snake River sockeye, which spawn in Idaho, were the first Pacific Northwest salmon population listed under the ESA. The population suffered a complete collapse, and annual run sizes between 1989 and 1998 ranged from 1 to 18 sockeye. The 1999 run size was only 19 fish, although the 2000 return jumped up to 447 sockeye – the largest annual return since 1977. This improvement is a direct result of recovery activities, including hatchery supplementation and protective fishery regulations.

The upper Columbia River sockeye spawn in tributaries to Lake Wenatchee and in the Okanogan River system. Like other sockeye populations in Washington, the abundance of upper Columbia sockeye can vary greatly from year to year. Over the last three decades these two sockeye populations have varied from a low of under 10,000 fish returning (1995) to a high of nearly 200,000 sockeye (1985). The 1999 and 2000 upper Columbia sockeye returns also displayed highly variable rates of return, with just under 18,000 fish in 1999, followed by a run of over 93,000 sockeye in the 2000 season.



A screw trap measures downstream migration of chinook and coho salmon on the Deschutes River.

APPLIED SALMON RESEARCH

Scientific research has long provided the foundation for salmon management in Washington state, never had that work been more critical than in the 1999-01 Biennium. With the listing in 1999 of seven new salmon and steelhead populations under the federal Endangered Species Act (ESA), virtually every management decision – from season openings to hatchery operations – rested on the ability of resource managers to determine the outcome with some measure of scientific certainty.

To meet that challenge, WDFW built on research and management protocols developed over more than three decades to improve understanding of issues ranging from hatchery straying to run timing. Data collected from coded-wire tags, a technology developed in the early 1970s, allowed WDFW to continue refining its forecasts of chinook and coho runs throughout the biennium. Analysis of otolith markings and DNA studies provided additional information on migration pathways, habitat preferences and harvest rates for specific salmon populations.

At state hatcheries, WDFW scientists drew on years of research in salmon culture to sustain and propagate depleted runs of wild salmon, while carefully assessing the impact of hatchery fish on wild runs. On the fishing grounds, selective fisheries became possible for the first time on a broad scale because of newly developed fin-clipping technologies. And in test fisheries conducted in Puget Sound, the Columbia River and Willapa Bay, two new types of commercial gear showed promise in dramatically reducing mortality among released fish.

Throughout the biennium, the Science Division of the Fish Program played a leading role in ensuring that agency management decisions were based on solid science and monitored to verify the results. Major new and ongoing scientific initiatives are discussed on the next page.

Marking Technologies

Mass-marking is a critical component of WDFW's efforts to conduct selective fisheries, allowing fishers to target hatchery-produced salmon while releas-

ing wild stocks. Department scientists also use marking techniques to assess compliance with ESA requirements, impacts of hatchery fish on wild stocks, and the life histories of salmon. Some new applications of marking techniques used during the biennium are listed below:

- **Otolith marking:** Thermal marking otolith of chinook in the Snohomish river basin demonstrated that local tribal fisheries largely target hatchery fish and can be opened without significant impacts on wild chinook. An ongoing marking effort, conducted by WDFW and the Tulalip Tribe, also determines the extent of natural spawning by hatchery fish.
- **Otolith strontium:** WDFW scientists used otolith strontium, a naturally occurring element far more abundant in seawater than in most freshwater areas, as a tool to discriminate between the progeny of anadromous females and freshwater resident females. Studies conducted at Baker Lake have demonstrated that the summer “kokanee” fishery actually targets anadromous sockeye. In Lake Washington, WDFW collected otoliths from spawning sockeye in Bear Creek from 1998 through 2000 to determine whether salmon originating from the Cedar River Hatchery were straying into the creek. After decoding 1,200 otoliths, WDFW found no evidence of straying.
- **Scale sampling:** Using natural growth patterns on scales, unmarked/untagged coho were sampled in the Columbia River commercial net fishery from 1999 through 2001 to estimate the hatchery/wild composition of that portion of the harvest.
- **VIT identification:** Department scientists helped to develop a new marking technology called the visible implant tag (VIT), which provides researchers with a quick, benign and unambiguous way to identify the origin of sampled

An otolith, the calcified tissue from a fish's inner ear, displays a distinctive pattern similar to the rings on a tree.



Using a radio telemetry device, a WDFW biologist monitors the migration of tagged adult salmon upstream.

fish. The VIT, made of biocompatible material with fluorescent coloring to make it highly visible, is inserted into adipose tissue and remains there throughout the life of the fish.

- **DNA testing:** WDFW significantly expanded its DNA laboratory and is now using this technique to identify and characterize stocks, determine population interrelationships, evaluate reproductive success and guide hatchery operations.

Hatchery Research

The new listings of salmon and steelhead populations in 1999 brought a new level of scrutiny of hatchery operations in Washington state, even as WDFW worked to realign its facilities with the goal of wild salmon recovery. During the 1999-01 Biennium, the Department filed 128 Hatchery and Genetic Management Plans (HGMP) with NMFS to demonstrate compliance with the ESA, worked with a new science panel created to Congress to prioritize funding needs and developed a new process for ensuring that supplementation and wild stock recovery programs carried out at state hatcheries do not negatively affect native fishes. Key initiatives include:

- **Benefit/Risk Assessment Procedure (BRAP):** WDFW developed this diagnostic tool to help analyze the compatibility of each state hatchery with the goal of recovering wild stocks. The procedure focuses on the presence of naturally spawning stocks, quality and availability of spawning habitat and other factors to

Tests find experimental gear improves salmon survival

Two new types of commercial fishing gear tested by WDFW in 2000 and 2001 appear to give salmon a much better chance of survival after they are returned to the water than traditional gillnets. Both types of experimental gear, known as the “tangle net” and the “floating box trap,” could help sustain commercial fisheries in a new era of selective fishing.

In a series of test fisheries conducted in Puget Sound and Willapa Bay from June through December of 2000, WDFW found that only 55% of the chinook and 75% of the coho salmon caught with a standard gillnet were still healthy enough to swim away from the boat after release. By comparison, about 80% of the chinook and coho salmon released from a tangle net, first introduced in British Columbia, still appeared healthy. Using the floating box trap, the survival rate at the time of release was virtually 100%.

The primary advantage of the tangle net is that it is designed with a smaller, looser mesh (3.5 to 4.5 inches) to capture salmon by the head or teeth, allowing them to respire while in the net. Gillnets, which can have a mesh size of up to 8 inches, usually catch salmon by the head, which can compress their gills and suffocate them. In addition, unlike standard gillnets, the tangle net seldom leaves net marks on the body of the fish, potentially increasing their market price.

Left to fish for the same amount of time, tangle nets used in the test fishery caught about half as many chinook but just as many coho salmon as the gillnet in most areas. The floating box trap, which captures salmon by funneling them into a small webbed chamber, had the highest survival rates of any gear but also caught the fewest fish. Tested only in Willapa Bay, the floating box trap caught a total of 36 salmon, 34 appeared healthy at the time of release.

A second round of tests conducted in 2001 on the Columbia River showed improved results. This time, WDFW also tagged and monitored salmon released from the tangle net in an effort to estimate long-term survival.

In a test fishery conducted under contract with the Bonneville Power Administration, WDFW estimated that 91% of the spring chinook salmon caught in a tangle net survived to move on to other fisheries, hatcheries and spawning grounds. That compares to a survival rate of just 50% of the fish released from a conventional gillnet. This time, the tangle net caught as many spring chinook as the gillnet.

Implementation of tangle nets and careful fish handling will provide increased fishing opportunity for the commercial gill net fleet. Future experiments with selective gears will verify the post-release survival for spring chinook, evaluate the post-release survival for coho and explore other possible gear types.

A report on last year's test fisheries involving the tangle net is posted on WDFW's website at <http://www.wa.gov/wdfw/fish/commercial/selective/tangleprogress1.htm>



A chinook salmon is pulled from the small, loose mesh of a tangle net during a WDFW test fishery.

help determine the degree of risk, if any, a hatchery facility poses to depressed or listed salmon stocks. Based on those assessments, specific hatchery operations may be modified or eliminated, depending on the measured risk to listed species. In the winter of 2002, the WDFW Fish Program will develop a hatchery reform plan in response to BRAPs conducted on Puget Sound facilities.

- **Hatchery and Genetic Management Plans (HGMPs):** Developed by the National Marine Fisheries Service, HGMPs are required for any hatchery program that could potentially affect a listed species. Once a HGMP is approved by the federal government, the corresponding program is deemed to be in compliance with ESA. During the 1999-01 Biennium, 87 of 94 draft HGMPs for Puget Sound hatchery programs and 41 of 52 draft HGMPs for Columbia River hatchery programs were completed and submitted to NMFS. These HGMPs are currently undergoing tribal and NMFS review. HGMPs for approximately 60 coastal programs are scheduled to be completed by December 2002. Once ESA authorization is attained, HGMPs remain in effect until the program significantly changes. Programmatic review is expected every three to five years.
- **Hatchery Scientific Review Group (HSRG):** The Puget Sound and Coastal Hatchery Reform Project was created by Congress in 2000 to conduct a systematic review of how effectively hatcheries achieve the goals of helping to recover natural populations and support sustainable fisheries. Under that initiative, a nine-member panel of independent scientists – the HSRG – was appointed to make recommendations to Congress and to the co-managers on hatchery improvements for use in prioritizing projects along with necessary state and federal funding. Those recommendations, along with WDFW actions, will be included in the agency's hatchery reform plan in 2002.
- **Salmon interactions:** In the most comprehensive program of its kind in the world, WDFW scientists

monitored the status and health of wild salmon populations to see if hatchery supplementation is beneficial or detrimental to wild salmon. Test results detected no impacts, but monitoring will continue for at least 30 years to make sure this is not the result of naturally occurring variations in fish populations.

- **Rearing pond tests:** Beginning in 1996, agency staff added inexpensive, floating and submerged structures at the Sol Duc hatchery to create a more natural rearing habitat. Preliminary results show the coho reared with in the modified raceways had a better survival rate than those reared in the standard containers. At the Elochoman Hatchery, agency scientists examined the differences in survival and physiology of salmon reared in a semi-natural rearing pond compared to those reared in a conventional hatchery pond. Fish from the semi-natural pond were larger at migration but the survival differential between the two groups was not as great as expected.
- **Genetic comparison:** In 2001, WDFW researchers completed the second year of a nine-year study at Minter Creek Hatchery comparing the genetic fitness of wild-spawning hatchery and native fish. The study will determine if the fitness of the hatchery fish is equal to that of the wild fish and if fitness changes over several generations.



A technician tags a smolt as part of the Yakima Klickitat Fisheries Project involved in salmon recovery work in the Columbia River Basin.



Salmon smolts, marked with new visible implant tags (VIT), are ready for release.

Habitat Research

WDFW has examined the effects of habitat alterations on salmonids over a number of years, focusing attention on the effects of piers and docks in marine and freshwater areas in the 1999-01 Biennium. These and other projects during the 1999-01 Biennium are summarized below.

- **Over-water structures:** The Department conducted a survey that found an average of one over-water structure per 150 feet of Lake Washington shoreline. Findings indicate that docks and other over-water structures provide hiding places for bass to prey on juvenile salmonids. The Department's goal is to identify ways to improve siting and design of docks to reduce predation of young salmon.
- **Puget Sound salmon interactions:** Collaborative research was initiated with the University of Washington in the spring of 2001 to determine the food competition and predation interactions between wild and hatchery-reared juvenile salmon in the nearshore waters of Puget Sound – the most altered marine habitat in the state.
- **Spawning studies:** WDFW led a multi-agency team studying the migratory behavior of maturing adult chinook spawning in the Lake Washington watershed. The team found that water temperatures around Ballard Locks and in the Sammamish River were critical to spawning chinook. Efforts are underway to provide cool water refuges in key areas for chinook during their migration to spawning grounds.
- **Priest Rapids Dam:** As part of a multi-agency protection plan negotiated with the Grant County PUD, WDFW staff gathered and analyzed data to test specific hydroelectric operational strategies at the Priest Rapids Dam. Dam operations cause rapid fluctuations in river flow that strand rearing fall chinook. WDFW is assessing actual fish and wildlife impacts and will use this information to help design a long-term operations plan.

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FRESHWATER FISH

THE WASHINGTON DEPARTMENT OF Fish and Wildlife (WDFW) manages an estimated 8,000 lakes and more than 90,000 miles of streams for fish and wildlife. The Freshwater Fish Unit manages these waters for resident native fish, warm water (spiny ray) fish, steelhead, freshwater shellfish and sturgeon. In all, the unit manages more than 65 species of fish and hundreds of species of aquatic invertebrates with the goal of perpetuating healthy populations and providing angling opportunities.

Freshwater fisheries provide the most angling opportunities in the state. In fiscal year 2000, nearly 729,000 anglers were licensed for freshwater fishing. By the following year, the number increased to nearly 1 million. Assuming that half of all two-day licenses were purchased for freshwater fishing, these license sales generated an estimated \$12.5 million for the Wildlife Fund in the first year of the biennium and more than \$18 million in the second year. These anglers fished an estimated 16.1 million days during the 1999-01 Biennium. These activities provide essential income to many small local communities that depend on tourism, and contributed substantially to the state economy.

Approximately 17 million freshwater fish are harvested by anglers each year. Much of this harvest is from natural production, but WDFW also has substantial hatchery stocking and lake rehabilitation programs. Last biennium over 55 million freshwater fish (4.5 million pounds) were stocked in lakes and streams with fish produced at 34 hatcheries operated by WDFW. This included cold water species (e.g., trout and kokanee), warm water species (tiger muskies, channel catfish) and steelhead. Hatchery production contributed to a diversity of fishing opportunities ranging from walleye in eastern Washington to trout in high ("alpine") lakes. Well over 90% of the steelhead harvested statewide were produced at hatcheries in Washington, Oregon and Idaho.

An important management tool traditionally used by the Freshwater Fish Unit has been lowland lake rehabilitation. Twenty-two lake rehabilitations were conducted in eastern Washington during 1999 and

2000 to remove undesirable fish and maintain quality trout and warm water fish fisheries. A moratorium was placed on rehabilitations in 2001 while a comprehensive health and safety review of the program was undertaken.

Freshwater fish and aquatic species play an important part in maintaining healthy ecosystems as well as providing recreational fishing opportunities. But the health of freshwater species is under increasing pressure due to population growth and other factors which have impacted fish habitat and water quality. In 1998 and 1999, bull trout were listed by the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act (ESA) throughout their entire five-state range. Department staff participated on the USFWS's multi-state bull trout recovery group to begin the first step toward recovery of the species. Steelhead in the middle Columbia River were also listed as "threatened" in 1999, and several other populations were petitioned for listing, including Issaquah Creek kokanee, coastal cutthroat in southwest Washington and green sturgeon. The Department currently is working with the USFWS on issues related to the listing petitions.

As part of its efforts to protect critical freshwater fish habitat, the Fresh Water Fish Unit during the past biennium continued its efforts to map the distribution of freshwater species. Information from this



Michael Skriletz, 12, holds a 7-pound walleye he caught in 1999 fishing in the lower Columbia River near Cathlamet.

activity is entered into various department databases and utilized by state, federal, local and tribal governments when making decisions on how to protect critical habitat for freshwater fish species.

The sections that follow cover staff activities directed at stewardship of the resource and providing freshwater fishery opportunities. Three major highlights for the 1999-01 Biennium included:

- **Youth Sport Fishing Program:** The program conducted 15 fishing events involving 8,900 young anglers and 680 volunteers throughout the state. A Youth Sport Fishing plan was developed and funded by the Legislature. The program's eventual goal is to interact with 24,000 kids annually.
- **Triploid Trout:** The Legislature authorized the Department to purchase up to \$400,000 worth of sterile (triploid) rainbow trout from private growers for stocking into lowland lakes. The Department purchased 44,000 fish in 2000, and 84,000 in 2001. Over 80 lakes throughout the state were stocked. The fish were large (averaging 1.5 lbs), drawing considerable interest by anglers. This program is expected to continue during the 2001-2003 Biennium at a slightly reduced level.
- **Meseberg Warm Water Fish Rearing Facility:** The first warm water fish rearing facility in the state received dedicated funding from the Legislature. Staff was hired to operate the Meseberg Hatchery/Rearing Facility, and im-



Nearly a thousand young people attended the WDFW Fishing Kids event in Vancouver during the summer of 2001.

provements were made to make it a fully operational hatchery, a milestone in providing fishing opportunities for warm water anglers.

RESIDENT/NATIVE FISH

The Resident/Native fish program unit is responsible for the management of resident trout, non-game fish species and freshwater shellfish. The resident trout program includes management of the lowland lake trout program, including landlocked salmon fisheries for kokanee, the high lakes trout program, and commercial crawfish harvest. Biologists also are involved in recovery planning efforts for weak and listed native resident fish stocks such as bull trout.

Trout Program

During the 1999-01 Biennium, WDFW's trout program provided recreational opportunity for at least a half million licensed anglers each year and an unknown number of anglers under the age of 15 who are not required to purchase a license. Those opportunities included lowland lakes fisheries, trout (including kokanee) fisheries, resident trout stream fisheries, high lakes trout fisheries and coastal cutthroat fisheries.

Lowland Lakes Trout Program

There are over 4,700 lowland lakes and reservoirs in Washington and about 400 of them are managed under WDFW's trout program. According to a 1995 angler preference survey, the lowland lakes trout program is the state's most important freshwater fishery in terms of both trips and participants. The survey estimated that nearly 36% of the total days fished in inland waters occurs in lowland lake trout fisheries.

The lowland lakes season opener, the last Saturday of April, is historically one of the most popular outdoor events held each year in Washington state. Each year, approximately 200,000 to 300,000 anglers, including juveniles who do not need a license, participate in this fishery, and the 2000 and 2001 openers were no exception. Fishing effort was high and anglers enjoyed catch rates averaging over three fish per person. The daily limit is five.

The total number of catchable trout, seven inches or larger, stocked into lowland lakes increased from

2.3 million in 1999 to 3 million in 2001. Also, 16.5 million trout fry were stocked during the spring of 2000 for the 2001 trout fishery. As previously noted, triploid trout, planted by WDFW for the first time with funding provided in the 1999-01 operating budget, also proved to be a major draw for anglers.

During the off-season, WDFW worked to improve the growth and survival of stocked trout fry by eliminating undesirable fish species that compete for space or food, or prey on them. In 2001, the Department undertook a comprehensive review of its rehabilitation program to address potential health and permitting issues, and the program has temporarily been put on hold until the review is completed.

Lake rehabilitation is typically undertaken with the use of rotenone, a natural pesticide which is applied in specified amounts to kill undesirable fish species. Trout fry stocked into a lake after it has been treated with this plant-derived chemical have high growth and survival due to the lack of competition from other species. The alternative to lake rehabilitation is to stock larger fish, 8 to 10 inches long, close to the season opener. These fish are not affected by competition and are large enough to avoid becoming prey.

Between July 1, 1999 and June 30, 2001, twenty-two lowland trout lakes with a total of 1,300 surface acres were rehabilitated to enhance trout fisheries. The treated trout lakes included: Marshall in Pend Oreille County; Warden, South Warden, Index, Quincy, Burke,



An angler plays a Dolly Vardon on the north fork of the Skokomish River, the largest river emptying into Hood Canal.

North Teal, South Teal, Beda, Brookie, Herons, Falcons, Goldeneye, Coot, Lenice, Merry, and Nunnally lakes in Grant County; Herman, Lyle, and Quail in Adams County, Hatch in Stevens County; and West Medical Lake in Spokane County.

Undesirable fish species in these lakes included yellow perch, pumpkinseed sunfish, brown bullheads, carp, stunted largemouth bass, bluegill and goldfish. Re-entry of undesirable fish from other waters into the drainage was the most common reason why these lakes required rehabilitation. In Marshall Lake, for example, the illegal placement of yellow perch and largemouth bass required that lake to be treated. The

Triploid trout a big hit in lowland lake fishery

Triploid trout were a major topic of conversation among freshwater anglers in 2000, when WDFW first starting stocking them in lowland lakes. Forty percent of those surveyed had heard about them and 10% said they were a significant factor in their decision to purchase a fishing license.

Voracious feeders, triploid trout are sterile rainbows that grow to an average size of 1½ pounds each. The 1999 Legislature authorized the department to purchase up to \$400,000 worth of "triploids" from private growers for stocking into lowland lakes and they proved to be a highly popular addition to the fishery.

In 2000, approximately 44,800 triploid trout were stocked into 43 lowland lakes, fished by an estimated 21,500 anglers. Preliminary information indicates the fish were easily caught and anglers reported high satisfaction with the new stock. In 2001 approximately 84,000 triploid trout were stocked in 77 lowland lakes around the state. Changes were implemented during 2001 to include lakes with restrictive gear regulations and reduced bag limits to provide better conditions for second-year survival of the fish. The Department plans to continue the popular fishery during the next biennium at a slightly reduced level.

Anadromous Fish Releases and Returns

WDFW Hatcheries 1999/2000

STEELHEAD (Summer Run)

	Fish Return	Fish Upstream	Egg Take	Egg Take Goal	Fish Released (**)
1999					
Puget Sound	1,449	973	590,000	300,000	373,798
Coast	457	0	338,500	325,000	157,472
Col. River	13,058	9,051	4,546,120	5,737,600	4,135,924
2000					
Puget Sound	801	122	811,500	890,000	294,456
Coast	1,640	0	445,000	315,000	174,630
Col. River	17,254	9,760	4,248,321	6,033,200	3,231,684

STEELHEAD (Winter Run)

	Fish Return	Fish Upstream	Egg Take	Egg Take Goal	Fish Released (**)
1999					
Puget Sound	816	175	1,556,980	2,810,000	2,025,960
Coast	3,972	613	3,558,000	2,130,000	752,216
Col. River	7,600	5,490	2,785,096	2,935,000	2,004,942
2000					
Puget Sound	1,095	253	1,955,330	2,821,000	1,838,763
Coast	2,428	713	2,378,500	2,421,000	1,386,933
Col. River	8,347	5,873	1,190,246	3,025,000	2,081,765

SEA-RUN CUTTHROAT

	Fish Return	Fish Upstream	Egg Take	Egg Take Goal	Fish Released (**)
1999					
Puget Sound	268	268	None	None	--
Coast	156	143	38,000	40,000	36,099
Col. River	10,393	814	385,400	585,000	376,596
2000					
Puget Sound	264	259	None	None	--
Coast	None	--	--	--	--
Col. River	15,851	1,212	864,000	675,000	345,486

last, and only other, time Marshall Lake required rehabilitation was in 1953.

High Lakes

Anglers have been traveling to the high elevations of the Olympic Peninsula and the Cascade Mountains for more than 100 years to fish in Washington's high lakes, also known as alpine lakes. There are approximately 1,600 lakes in western Washington at

elevations of at least 2,500 feet above sea level. East of the Cascades, nearly 950 lakes lie above 3,500 feet, which qualifies them as high lakes. A survey of freshwater anglers in 1995 indicated that 175,000 anglers spend 1.35 million days fishing in high lakes each year. Angler use at present is believed to be equal or higher to the 1995 estimate.

The Department coordinates closely with constituent groups to stock high lakes and maintain fisher-

Freshwater Fish Releases and Returns

WDFW Hatcheries 1999/2000

	Egg Take	Egg Take Goal	Fish Planted **
RAINBOW TROUT			
1999			
Puget Sound	2,322,883	2,650,000	2,929,942
Coast	None	--	70,264
Col. River	15,399,228	15,880,000	5,854,639
2000			
Puget Sound	3,398,100	2,650,000	2,805,089
Coast	None	--	75,615
Col. River	14,665,612	15,880,000	7,172,785

CUTTHROAT TROUT			
1999			
Puget Sound	654,050	650,000	599,179
Col. River	1,671,025	1,791,000	720,284
2000			
Puget Sound	948,775	850,000	537,523
Col. River	1,860,678	1,791,000	1,057,657

BROOK TROUT			
1999			
Puget Sound	None	--	19,256
Col. River	1,075,995	900,000	239,269
2000			
Puget Sound	None	--	27,247
Col. River	309,628	900,000	310,622

BROWN TROUT			
1999			
Puget Sound	None	--	105,022
Col. River	1,619,256	1,000,000	558,375
2000			
Puget Sound	None	--	73,000
Col. River	2,161,929	1,000,000	547,425

	Egg Take	Egg Take Goal	Fish Planted **
GOLDEN TROUT			
1999			
Puget Sound	22,900	10,000	10,110
2000			
Puget Sound	None	10,000	18,348
Col. River	None	--	3,488

LAKE TROUT			
1999			
Puget Sound	None	--	1,015
Col. River	None	--	87,875
2000			
Col. River	None	--	85,606

TIGER TROUT			
2000			
Col. River	--	--	3,269

KOKANEE SALMON			
1999			
Puget Sound	14,662,542	13,650,000	7,083,891
Col. River	181,200	None	2,528,110
2000			
Puget Sound	11,072,148	13,650,000	7,825,286
Col. River	180,000	5,425,000	3,783,574

(*)= data for 2000 are preliminary.

(**)= Fish Released originate from the previous year's egg take.

ies. In each year of the biennium, approximately 40 volunteers helped to carry fingerlings into high lakes to be planted. Stocking has focused on maintaining the health of the lake ecosystems either by stocking at low densities, not stocking every lake, or avoiding stocking that could result in self sustaining populations. During the 1999-01 Biennium, approximately 400 lakes were stocked with more than 400,000 fish. This level of stocking has remained relatively constant over the last 10 years.

Native Nongame Freshwater Fish

In addition to such better-known species as rainbow trout and steelhead, Washington is home to 31 species of native freshwater fish that are not considered "game fish." And while such species as sculpins, chub, suckers and lamprey may not attract the attention of anglers, they do often play an important role within their various ecosystems. Some are an important source of food for other fish and animals; oth-

Status of Washington's Native Freshwater Gamefish Stocks

Very few native resident fish stocks are monitored due to limited resources. One exception is bull trout. Currently, it is the only resident fish species in Washington that is listed under the federal ESA, although petitions have been submitted to the U.S. Fish and Wildlife Service (USFWS) for Issaquah Creek kokanee, Southwest Washington/Lower Columbia coastal cutthroat, and green sturgeon. WDFW staff are actively engaged in recovery activities for bull trout and are working with the USFWS on issues related to the other petitions.

Bull Trout

In June of 1998, the U.S. Fish and Wildlife Service (USFWS) listed the Columbia River Distinct Population Segment (DPS), which includes all Washington's bull trout populations in the Columbia River Drainage, as a threatened species under the federal ESA. This action was followed by a listing of Washington's coastal populations in November of 1999. Presently bull trout are listed throughout their U.S. range, which includes Washington, Idaho, Oregon, Montana and Nevada.

There are 175 populations included in the listing, of which more than 80 are in Washington. The status of 72% of Washington's stocks is unknown due to a lack of resources to monitor them. However, nearly 18% of the total stocks are believed to be healthy, 3% depressed and 8% critical.

During the 1999-01 Biennium the Department participated in the following actions to address bull trout recovery/management:

- Participated in USFWS's multi-state agency recovery planning effort.
- Established seven recovery planning groups and initiated planning efforts for Washington bull trout populations.



Eight percent of Washington's bull trout populations are believed to be in critical condition. The status of most stocks is unknown due to a lack of resources.

- Conducted spawner surveys in 24 drainages, a threefold increase over the previous biennium.
- Carried out life history studies using radiotelemetry in the Tucannon and Touchet systems.
- Implemented numerous fishing regulations to protect the species.

These efforts appear to be having a positive effect, at least in some areas. Surveyors in the Lewis River system estimated 540 bull trout in 2000, nearly 100 above the previous, best count. Surveyors in the Touchet and Walla Walla systems saw increased bull trout redds in those systems during the past two years, and increased numbers of bull trout in the Skykomish system were reported. Bull trout numbers in the Yakima system appeared to be relatively stable; in 2000, Indian Creek bull trout redd counts were the highest since 1984.

Kokanee

The early-run Issaquah Creek kokanee population reached critically low population levels and was petitioned for listing as endangered under ESA in March 2000. Less than 10 kokanee were observed in the last two spawning seasons (1999 and 2000). A determination of listing is pending federal review. In a cooperative effort between WDFW, the Muckleshoot Tribe, King County, City of Issaquah, USFWS, and the King Conservation District, planning and implementation of a supplementation program for Issaquah Creek's early-run kokanee was initiated this past biennium with funding from the conservation district.

Cutthroat Trout

Both species of Washington's native cutthroat species were petitioned for listing as threatened under ESA. The USFWS determined that a listing for the westslope cutthroat was not warranted. The listing decision for Southwest Washington/Lower Columbia coastal cutthroat is expected in June of 2002. Coastal cutthroat distribution investigations began in Southwest Washington in May of 2001. During the last two months of the 1999-01 Biennium, 32 sites on the Cowlitz, Lewis, White Salmon and Washougal rivers were surveyed to determine the presence or absence of coastal cutthroat. Cutthroat were found at four of those sites. The 32 sites were all located in headwater areas.

WDFW staff has been working with USFWS to develop an ESA rule proposal for the Southwest Washington/Lower Columbia coastal cutthroat DPS should they be listed. This will allow important fisheries for other species to continue should a listing occur.

ers play an important role in mosquito control. Many are clearly visible in lakes and streams, adding to our appreciation of the outdoors.

Recognizing the value of these species to the natural environment, the Nongame Fish Unit worked during the 1999-01 Biennium to determine their distribution, habitat preferences and stock status. Two WDFW fish biologists sampled 154 different stream and lake sites to help develop distribution maps for each of the 31 species. The maps will be included in the second edition of the book *Inland Fishes of Washington*, along with a new identification key, developed by staff, to the 10 freshwater sculpins of Washington.

One nongame fish species, the Olympic mudminnow, was added to the state's list of "sensitive" species during the 1999-01 Biennium, joining the pygmy whitefish and the margined sculpin. The Washington Fish and Wildlife Commission approved the Department's proposal to list the mudminnow as a state-sensitive species because of its limited range (southeast Olympic Peninsula), and because of the loss of much of its primary habitat-lowland wetlands over the years.

Five species of native nongame fish presently are listed as "state candidate" species. The Umatilla dace, river lamprey, leopard dace, lake chub, and mountain sucker are all listed under this category. WDFW continued efforts to locate these species during the 1999-01 Biennium, and their status is still under review.

All nongame fish distribution data is compiled and is stored in WDFW databases. This information is made available to WDFW biologists as well as municipalities and other state and federal entities that need to evaluate the impacts of various projects on fish, wildlife and their habitats. Work was also initiated during the biennium on a nongame fish web page to make the information more accessible to governmental agencies and the general public.

Commercial Crawfish Fishery

WDFW manages a commercial fishery for crawfish in cooperation with treaty tribes in western Washington. Currently the commercial crawfish fishery is small relative to historical records. Fishing participation was down from the previous five-year av-



Gold Hill Lake, a high lake in Yakima County, is known for producing cutthroat trout.

erage (1994-1998). There were four active fishers in 1999 and 2000 compared to the five-year average of six. Total landings reported were 7,137 and 7,553 pounds for 1999 and 2000, respectively, up 8.9% and 15.2%, respectively, from the five-year average. Low market price may be a reason for the low participation. Prices reported on crawfish receiving tickets for 1999 and 2000 ranged from 75 cents to \$2.25 per pound.

STEELHEAD

Washington steelhead offer a unique fishing experience, attracting anglers from throughout the state, the nation and the world to catch one of the Northwest's premier sport fish. Major fisheries are conducted each year on rivers in the Puget Sound area, along the Pacific coast and on the Columbia River and several of its tributaries. Most river systems in these areas have annual returns of both hatchery and wild fish, with runs during both summer and winter months.

WDFW manages steelhead stocks in cooperation with federally recognized treaty Indian tribes, working with tribal co-managers to estimate run sizes, determine escapement objectives and establish harvest allocations. Harvest opportunities are shared between tribal and non-tribal fishers, in accordance with the federal court decisions. Exceptions are streams south of Grays Harbor and tributaries to the lower Columbia where there are no recognized treaty rights.

Between August 1997 and March 1999, the National Marine Fisheries Service listed four naturally spawning steelhead populations on the Columbia and Snake rivers under the federal ESA. Listed populations include:

- Lower Columbia River steelhead, listed as threatened March 19, 1998
- Middle Columbia River steelhead, listed as threatened March 25, 1999
- Upper Columbia River steelhead, listed as endangered August 18, 1997
- Snake River steelhead, listed as threatened August 18, 1997

In all areas of the state, steelhead fisheries are designed to maximize harvest of hatchery fish, while ensuring that spawning requirements for wild fish are met. On the Columbia and Snake rivers, WDFW worked closely with federal, tribal and other management entities to develop recovery strategies for listed populations. Fisheries were curtailed – not only for steelhead but also for trout and whitefish – to minimize impacts on depressed runs. The use of bait was also prohibited in areas of both rivers to reduce impacts on wild steelhead.

An estimated 90,000 anglers fished for steelhead in each year of the 1999-01 Biennium, an increase from 1997 when 86,700 anglers participated in the fishery. However, participation levels were still well below those in the 1960s and 1970s, when up to 160,000 anglers fished for steelhead each year. This overall decline in angler participation is due to a number of factors, including the closure of some waters to protect listed populations. In addition, ocean conditions during the 1990s were generally poor for steelhead, resulting in low returns. However, as with many salmon populations, returns of many steelhead populations showed a significant increase, marking the start of a possible upward cycle in steelhead abundance in many areas of the state.

Steelhead Hatchery Production

Angler catch records indicate that more than 90% of all steelhead harvested statewide were produced at hatcheries in Washington, Oregon and Idaho. Since the mid-1980s, all steelhead produced in Washington hatcheries have been marked by clipping their adipose fin to facilitate identification by anglers and fish managers. During the 1999-01 Biennium, 20 state hatchery facilities produced steelhead for har-



A WDFW employee holds a returning steelhead at the Kalama Falls Hatchery, where the Department has been studying the interaction of wild and hatchery fish.

vest and six of them also operated “supplementation” programs designed to facilitate the recovery of depressed wild populations.

State facilities involved in recovery efforts on the coast and in Puget Sound include those on the Hamma Hamma River and Lake Washington. Those involved in steelhead recovery on the Columbia River include those at the Tucannon River, the Touchet River, the Cowlitz River and the mainstem Columbia above Priest Rapids Dam. Hatchery fish returning to the upper Columbia River have been listed under the ESA as an essential component of wild steelhead recovery in that area.

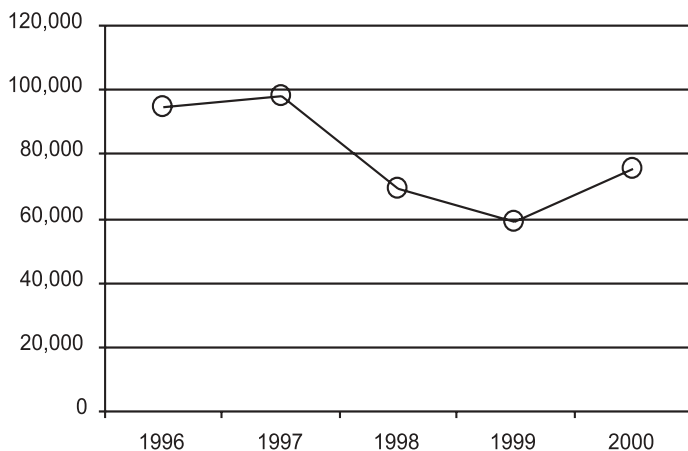
From 1994 through 1998, steelhead smolt production by agency facilities and volunteer cooperative projects averaged 7.4 million fish. In 1999 and 2000, smolt production increased to approximately 7.8 million fish.

Abundance and Harvest Trends

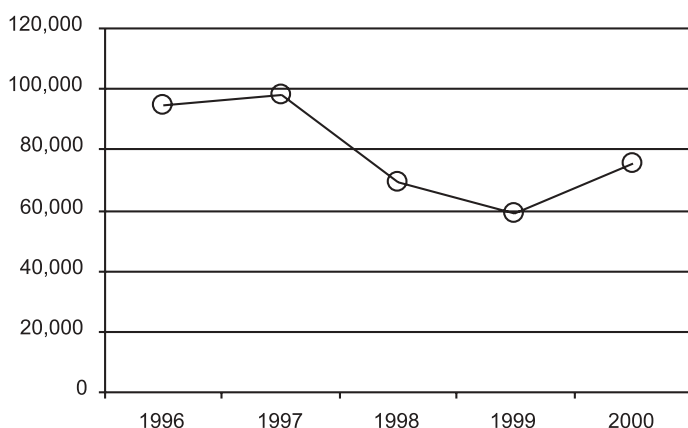
Overall steelhead abundance and harvest trends varied significantly by region during the 1999-01 Biennium. In 2000, wild stocks dropped unexpectedly

STEELHEAD HARVEST

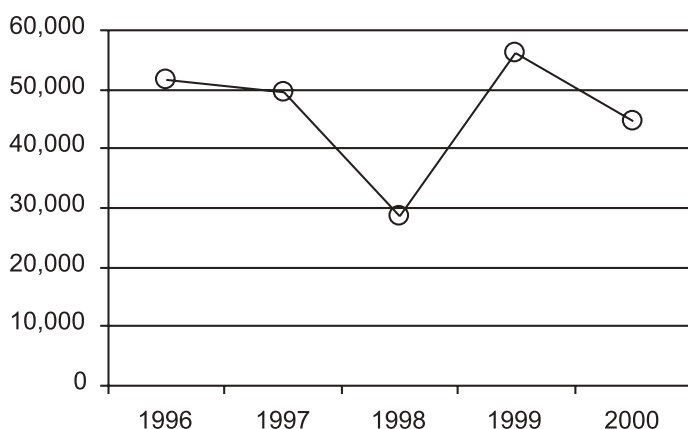
Sport Catch by Region



Statewide Sport Total



Statewide Tribal Total



in Puget Sound, but remained healthy on the coast and showed some improvement on the Columbia River. WDFW took emergency action on a number of rivers during the 2000-01 season in response to low returns in Puget Sound.

Statewide, sport fishers harvested 58,700 summer and winter steelhead in 1999 and 76,250 summer and winter steelhead in the year 2000. Of those totals, approximately 8.4% of the fish taken in 1999 were wild, declining to 5.3% in 2000. Tribal fishers harvested 56,250 steelhead in 1999 and 44,525 in 2000. Since the 1995-96 season, the catch by non-tribal anglers has averaged 79,400 fish and the catch by tribal fishers has averaged 46,350 fish. Below is a summary of wild steelhead abundance and area harvest trends for each of the three steelhead management regions.

Puget Sound Region: The status of wild steelhead stocks returning to tributaries of Puget Sound, including the Strait of Juan de Fuca and Hood Canal, declined from generally healthy to depressed during the biennium. Wild run sizes in North Puget Sound crashed unexpectedly in 2000, prompting WDFW to close some areas to fishing by emergency order and require the release of wild steelhead in others. In 2001, spawning escapement estimates for wild steelhead indicated North Puget Sound run sizes would be from 40% to 80% of escapement objectives. Runs in South Puget Sound and Hood Canal also were depressed, although streams along the Strait of Juan de Fuca were close to escapement levels, producing harvestable numbers of wild steelhead.

In 1999, sport anglers caught 15,800 steelhead and tribal fisheries took 3,700, for a total yearly harvest of 19,500 fish. In 2000, sport anglers caught 12,400 steelhead and tribal fishers took 3,700, for a total annual harvest of 16,100 fish.

Coastal Region: Wild steelhead stocks returning to coastal rivers remained healthy throughout the biennium. Wild run sizes in waters of the northern portion of the coast – particularly the Quillayute, Hoh, and Quinault rivers systems – produced substantial numbers of wild



A hatchery worker plants wild steelhead broodstock at the Kalama Falls Hatchery, where research is under way on supplementing wild runs.

steelhead meeting escapement objectives and providing harvest opportunities. Tributaries such as the Humptulips, Chehalis and Willapa Harbor river systems rebounded and produced run sizes that met or exceeded wild spawning objectives.

In 1999 sport anglers caught 10,200 steelhead and tribal fishers caught 35,600 for a total harvest of 45,800 fish. In 2000, sport anglers caught 14,600 steelhead and tribal fishers caught 20,000 for a total harvest of 34,600 fish.

Columbia River Region: While hatchery steelhead returns to the Columbia River basin have improved in recent years, wild stocks remained depressed in 1999 and 2000. Increased water flows during smolt out-migration and improved ocean survival helped to boost returns of all stocks, but not to the levels required to meet escapement objectives for wild steelhead. However, preliminary data for 2001 indicated marked increases in wild steelhead returns that year.

In 1999, recreational anglers caught 32,700 steelhead and tribal fisheries took 16,900, for a total annual harvest of 49,600 fish. In 2000, anglers caught 49,200 steelhead and tribal fishers took 20,800, for a total harvest of 70,000 fish.

WARMWATER FISH

The Warmwater Fish Program includes management and research activities involving 17 species commonly referred to as “warmwater” or “spiny-rayed” game fish. Both terms refer to this group’s relative tolerance to warmer water temperatures and the fact that most of these species have at least some rigid fin rays, or “spines.” The most well known and recreationally important members of this group include: largemouth bass, smallmouth bass, walleye, channel catfish, yellow perch, white and black crappie, bluegill sunfish and tiger musky.

None of the species in this group are indigenous to the State of Washington. All were introduced over a period spanning from the late 1880s, to as recently as the late 1980s. Most of these species were imported to Washington from the mid-western region of the country by the United States Fish Commission, acting on behalf of the region’s early settlers, who longed for fish species that were more familiar and reminiscent of home.

Fishing for warmwater fish is very popular in this state and has increased steadily until it is the second largest recreational fishery for game fish. There are many clubs and organizations focused on warmwater fish and fisheries including Walleyes Unlimited and B.A.S.S. The number of warmwater anglers is expected to continue to increase in the future and managing these species will become more important.

A major boost to warmwater fish management occurred in 1996 when the Legislature authorized a \$5 license to fish for bass, walleye, crappie, channel catfish and tiger musky. Senate Bill 5159 created the Warmwater Fish Enhancement Program (WFEP) and has provided more than \$1 million annually from license fees to fund projects to improve warmwater fish populations and fisheries.

Warmwater Fish Stock Status

Rarely do freshwater fish populations remain stable for an extended period without some form

of management intervention. When the predator-prey relationship is in an unbalanced condition, fishing opportunity and catch decline. Through periodic population surveys, assessments and management intervention, it is possible to prevent and/or reduce the length and severity of these swings in population balance, and thereby produce dramatic increases in opportunity and catch from existing fisheries. This approach is successfully employed by every state and provincial fish management agency in North America to improve fishing for warmwater fish species.

Since the establishment of the WFEP, a total of 49 warmwater fish population surveys have been completed. Approximately 30% of the lakes surveyed were in a balanced state regarding predator/prey relationships. During the last biennium, a total of 19 warmwater fish population surveys were completed.

Growing Popularity

Collectively, warmwater species comprise one of the most economically valuable and recreational important fish resources in Washington. A survey of gamefish anglers fishing in Washington in 1995 estimated that more than half fished for warmwater species. Warmwater angling accounted for an estimated 3.48 million days of recreation, or nearly a quarter of the total number of days fished for all game fish species combined in 1995.

The amount of recreation provided by warmwater species in 1995 ranked second only to that spent on lowland lake trout fisheries, and surpassed the amount of recreation provided by steelhead or salmon fishing. Approximately 25% of Washington's li-

censed game fish anglers expressed a preference for warmwater species over all other game fish. Both the level of activity and angler preference for warmwater species has increased steadily.

License simplification prior to the 1999-01 Biennium combined the warmwater license with the general freshwater license. This requires an annual survey of anglers to determine individual participation in fisheries for the seven warmwater fish species. Annual surveys of licensed anglers were completed in June 2000 and 2001. This WFEP user index closely follows user trends in the total warmwater fisheries program for the state.

The 41% increase in angler participation seen from fiscal year 2000 to fiscal year 2001 may have been due to changes in the fishing licenses structure, while the 18% increase seen between fiscal year 2001 and 2002 may be more indicative of growth of the WFEP and the total Warmwater Fish Program.

Warmwater Fish Production

During the 1999-01 Biennium, the warmwater fish production program at the Meseberg Hatchery proceeded with the propagation of black crappie, bluegill sunfish, saugeye, tiger musky, and channel catfish. All of these species need some extended rearing prior to being stocked into lakes around the state. Four additional rearing ponds have been acquired from the Ringold Salmon/Steelhead Hatchery to increase production capacity.

In addition to the production at the Meseberg Hatchery, statewide fish stocking of bluegill, black crappie, largemouth bass, tiger musky and channel cat-

fish continued from fish transfers with Idaho Fish and Game and purchases from Nebraska and California. Other production activities included collecting largemouth bass and bluegill from lakes that are overpopulated or scheduled for rehabilitation. These

Warmwater Production Summary

	1996	1997	1998	1999	2000
Walleye	267,226	664,319	292,196	510,223	0
Saugeye	0	0	0	0	2,275
Black Crappie	0	12,484	41,625	92,140	1,425
White Crappie	0	853	0	0	0
Tiger Muskie	0	5,503	3,081	1,980	6,300
Largemouth Bass	0	120,173	3,995	168	892
Smallmouth Bass	0	322	8,996	0	0
Blue Gill	0	----	22,954	115,940	36,704
Channel Catfish	12,350	75,155	45,672	38,761	21,446
Grand Total	279,576	878,809	418,519	759,212	69,042

Grand Total Production All Years 2,405,158

collected fish were transferred to waters where fish biologists have identified specific needs.

Youth Warmwater Fishing

The Warm Water Enhancement Program funded the Department's popular youth fishing program throughout the biennium. In 2000, 280 volunteers assisted more than 3,800 children at WDFW fishing events in six Washington cities. Nine youth fishing events occurred in 2001, and were attended by 5,100 children and more than 400 volunteers. With funding provided by the Legislature for a new youth fishing program, WDFW will sponsor 12 Fishing Kids events each year starting in 2002.

Warmwater Fish Enhancement Projects

The Warmwater Enhancement Projects Program acquires and improves habitat and warm water angler access statewide. Funds are also directed at maintenance and improvements at current WDFW warmwater fishing access sites. Since July of 1999, various warmwater enhancement projects have been completed, including boat ramp construction at Sprague Lake; ramp replacement at Silver Lake; aerator installation at Fazon Lake; access road and ramp improvements at Potholes and Evergreen Reservoirs, Sportsman's, Billy Clapp, Soda and Alkali Lakes; a carp barrier installation at Hutchinson and Shiner Lakes; and the purchase of property for a boat launch at Lake Kapowsin. Over 50 warmwater boat accesses were also maintained using warmwater funds.

Similar projects are currently under way including boat-loading float installations, access purchases, outlet screen installation, access road construction, fish-rearing cove construction, boat ramp improvements, warm water fish habitat projects and parking lot construction for walk-in fishing opportunities. This program continually pursues and receives hundreds of thousands of dollars in matching funds and partnerships from other state and federal agencies as well as private organizations.

Sturgeon

Two species of sturgeon exist in Washington, white and green. White sturgeon are the most abundant and support important sport and commercial fisheries. These fisheries are primarily in the Columbia River,

Willapa Bay and Grays Harbor, with small recreational fisheries occurring in the Puget Sound region. By far the largest fishery is in the lower Columbia River and is managed jointly with Oregon. As salmon fishing opportunities decreased in the 1990s, many anglers began targeting sturgeon, including charter boat operators. Catch-and-release fishing for sturgeon has also become very popular with anglers.

Sturgeon Management

One of the major initiatives undertaken during the biennium was the implementation of Fish and Wildlife Commission's management policy for Lower Columbia River sturgeon. The three-year management accord between WDFW and the Oregon Department of Fish and Wildlife was renewed. Annual white sturgeon harvest was set at 50,000 fish for 2000-2002, allocated 20% to the commercial fishery and 80% to the sport fishery. This required seasonal retention closures for the sport fishery. Staff



Agency biologists examine an "oversize" sturgeon found dead on the Columbia River. Fishing rules prohibit the retention of a sturgeon over 60 inches.

worked closely with constituents to craft these closures. The boat angling sanctuary for spawning sturgeon on the mainstem Columbia River downstream from Bonneville Dam was extended an additional two weeks to comply with the Commission's policy to reduce impacts to spawning sturgeon.

Under this management regime, Washington anglers averaged 94,500 trips, and harvested 23,200 white sturgeon per year from July 1999 through June 2001.

Stock Status

For the past 17 years, WDFW has received funding from the Bonneville Power Administration for biological studies on the impounded white sturgeon populations in the Columbia and Snake river reservoirs. The work is aimed at addressing population declines and reduced productivity due to dam construction and operation. Work within the Columbia

River tribal management zone (Bonneville Dam upstream to McNary Dam) includes supplementation of depressed populations through transplants of wild juvenile white sturgeon from the healthy Lower Columbia River population, and intensive harvest management and fishery monitoring. Other efforts include annual monitoring of white sturgeon natural production in selected Columbia and Snake river reservoirs, and participation in an experimental conservation hatchery supplementation project.

The Department is also involved with the Upper Columbia Sturgeon Recovery Team, a group comprised of researchers and managers representing U.S., tribal, and Canadian governmental entities. The focus is on developing and implementing a recovery plan for the imperiled trans-boundary white sturgeon population residing in the Columbia River from Grand Coulee Dam upstream to Keenleyside Dam in British Columbia. ■

MARINE FISH

PACIFIC SOLE, COD, HERRING, halibut, sardines – these are just a few of more than 200 species of marine fish that live their entire lives in the salt water environs of Puget Sound, coastal bays and the Pacific Ocean. Some, such as albacore tuna, are highly migratory, crossing the Pacific in large schools every year. Others, such as copper rockfish and quillback, seldom stray from a single rockpile. Pound for pound, marine fish represent the majority of all fish caught in Washington state waters, with annual landings far surpassing those for shellfish, salmon, trout and all other species combined.

In the 1999-01 Biennium, non-tribal commercial fishers landed a total of 108.8 million pounds of marine fish in Washington ports, with an ex-vessel value of \$27.6 million. Commercial fisheries on the coast and in Puget Sound accounted for about 93% of all marine fish landings, although recreational fisheries also made a significant economic contribution to the state and to coastal communities in particular. Recreational anglers and divers made more than 1.6 million trips to catch marine fish during the biennium, generating business for coastal merchants during the off-season for other fisheries.

Because of the large number of marine fish species and the wide variation in their characteristics, marine fish are divided into four categories for management purposes:

- **Groundfish:** Include such species as sole, cod, flounder and rockfish, which live close to the ocean bottom.
- **Forage fish:** Include such species as herring, anchovy, sardine, and smelt, which serve as a major source of food for other fish, seabirds and marine mammals.
- **Highly migratory species:** Include such species as thresher sharks and albacore tuna that cover great distances each year.
- **Unclassified marine fish:** Include such species as tidepool sculpins and blennies, which are typically small in size and historically have been of minimal interest to commercial or recreational fisheries.

As state and tribal fisheries have grown and expanded into new areas, many species – particularly groundfish that live near the ocean floor – have shown a dramatic decline in abundance in recent years. On the Pacific coast, the catch of such groundfish as lingcod, Pacific Ocean perch and various types of rock-



The copper rockfish has historically been one of the most common rockfish in Puget Sound. – Don Rothaus/WDFW

fish has dropped from 70 million pounds per year to about half that amount since the early 1980s. In Puget Sound, the decline in landings during that time has been even more severe, dropping 90% to less than 3 million pounds per year.

In 1999, the National Marine Fisheries Service (NMFS) considered a petition to list seven marine fish under the federal Endangered Species Act (ESA) and the U.S. Department of Commerce declared the entire West Coast groundfish fishery a “disaster” the following year. Although NMFS ultimately determined that none of the species warranted listing under the ESA, the Pacific Fishery Management Council (PFMC) imposed major reductions in the groundfish catch in federal waters beyond three miles of the coastline.

Compared to salmon and most freshwater fish, many species of groundfish are slow-growing, long-lived fish that reach reproductive age late in life. These factors make recovery of depleted groundfish stocks a long-term commitment, which was initiated through a series of actions in the 1999-01 Biennium.

To protect groundfish in state waters, the Washington Fish and Wildlife Commission took action in December 2000 to prohibit bottom trawling within three miles of the coast and adopted several new restrictions on the harvest of groundfish in Puget Sound. In all of these actions the Washington Department of Fish and Wildlife (WDFW) worked to provide state and federal decision-makers with information on stock conditions and expand scientific knowledge about marine fish and their habitat.

While groundfish conservation was the dominant issue in marine fish management during the 1999-01 Biennium, WDFW worked with the Fish and Wildlife Commission, tribal fisheries managers and others on a number of other key issues, including:

- **New marine reserves:** Two new conservation areas (no-fishing zones) and one marine preserve (most fishing prohibited) were established in Puget Sound to serve as “natural hatcheries” for marine fish of all kinds.
- **Trial sardine fishery:** Responding to dramatic growth in the abundance of sardines in coastal waters, the Commission approved a trial fishery for purse seiners in the summer of 2000 – the first such fishery in 50 years. A total of 10.8 million pounds of sardines were landed that year, followed by 24.4 million pounds in 2001.
- **Unclassified marine fish:** Prior to May 2000, the harvest of many small marine fish such as sculpins and blennies that occupy shallow water and intertidal areas was unregulated. Concerned about the growing demand for these species, the Fish and Wildlife Commission adopted daily bag limits to prevent overfishing of these near-shore marine fish.
- **Ban on live-fish fisheries:** In 1999, an increasing number of fishers approached WDFW

Landings of Marine Fish from Washington Waters 1996-2000 (Non-Treaty)
(Millions of pounds)

Year	COASTAL AREA		PUGET SOUND		ALL AREAS		
	Commercial	Recreational	Commercial	Recreational	Commercial	Recreational	All Landings
1996	41.8	1.2	3.5	1.6	45.3	2.8	48.1
1997	32.0	1.1	1.5	0.9	33.5	2.0	35.5
1998	38.6	1.8	1.8	2.5	40.5	4.3	44.7
1999	39.1	1.1	1.2	1.0	40.3	2.1	42.4
2000	42.1	0.9	1.0	1.0	43.7	1.9	45.6

about capturing marine fish live and selling them to restaurants, some of which were offering top dollar for this product. After checking with California and other states where live-fish fisheries had gained popularity, WDFW identified several problems, including increased pressure on declining groundfish stocks, competition with existing fisheries and a variety of enforcement issues. At WDFW's recommendation, the Fish and Wildlife Commission prohibited live-fish harvest of marine fish in November of 1999.

At WDFW, marine fish are managed by the Marine Resources Unit, which also has responsibility for managing shellfish within the Department's Fish Management Division. The total operating budget for the Marine Resources Unit during the 1999-01 Biennium was \$11.16 million, which includes state, federal and local funds. The unit had a total of 96.7 FTE staff, assigned to a variety of management and research responsibilities. Throughout the biennium, WDFW's Marine Resources Unit worked closely with the Fish and Wildlife Commission, tribal fisheries managers, PFMC, NMFS, fishers and other interested parties to meet the Department's goals of protecting the resource while providing fishing opportunities on healthy stocks.

Groundfish

Commercial and recreational fisheries off the coast of Washington routinely catch 82 species of groundfish, many of which are also found in Puget Sound. These species, led by Pacific whiting, arrowtooth flounder and sablefish, accounted for 78% of all marine fish landed in Washington state during the 1999-01 Biennium.

Of those species, only 23 have received formal stock assessments, due to the cost and difficulty involved in evaluating fish that live near the ocean floor over a wide geographical and bathymetric area. The status of coastal marine fish resources is determined under the leadership of the PFMC, which includes representatives of Washington, Oregon, California, Idaho, the federal government, treaty tribes and fishing organizations. For the "inside" waters of Puget Sound, WDFW focuses its monitoring efforts on such indicator species as Pacific cod, dogfish shark and copper rockfish rather than attempt to assess the status of all groundfish stocks.

Management of groundfish fisheries is shared by the state of Washington (the Fish and Wildlife Commission and WDFW), treaty tribes, the federal government (NMFS) and the PFMC, with the membership discussed earlier. The state and treaty tribes share responsibility for all fisheries within three miles of the coastline, while federal agencies have jurisdiction for those beyond that point out 200 miles.

Coastal Groundfish Actions

Throughout the 1980s and 1990s, as coastal groundfish stocks showed signs of decline, the Fish and Wildlife Commission and the PFMC imposed an increasing number of restrictions on both commercial and recreational fisheries. Reductions were made in commercial quotas and recreational bag limits, and a growing number of areas were closed to fishing both inside and outside of the three-mile line.

Despite these measures, NMFS declared in 1997 that seven coastal species were officially "overfished," defined as an abundance level less than 25% of what



Pacific cod are loaded into a tote at a fish processing plant on the Washington coast.

would be expected without fishing activity. Those seven species are lingcod, canary rockfish, yelloweye rockfish, Pacific Ocean perch, darkblotched rockfish, widow rockfish and cowcod.

In response to these findings, the PFMC implemented a conservation plan that included major reductions in the groundfish catch. For canary rockfish, a new coastwide quota was established as part of a long-term rebuilding plan for that species. The daily bag limit for recreational fishers was reduced to a combined total of two canary and yelloweye rockfish (commonly called “red snapper”), which also appear to be overfished. These and other conservation measures took effect in 2000, when the U.S. Department of Commerce declared the entire West Coast groundfish fishery a “disaster.”

While the majority of the groundfish harvest takes place in waters beyond three miles of the Washington coast, the federal action prompted concerns that more trawlers would move shoreward into state waters to escape the new federal restrictions. To prevent that from happening, and to provide greater protection for in-shore species, the Fish and Wildlife Commission voted in December 2000 to prohibit bottom trawling in all coastal waters of the state.

Protective Actions in Puget Sound

Concerns about declining groundfish stocks were not limited to coastal waters. In February 1999, NMFS received a petition to list 18 species of marine fish in Puget Sound – all but one of them groundfish (herring) – for protection under the ESA. WDFW also identified seven stocks as candidates for the state’s own list of threatened and endangered species. Puget Sound stocks identified by WDFW as being in critical condition include walleye pollock in north Puget Sound, walleye pollock in south Puget Sound, Pacific whiting in south Puget Sound, and Pacific cod in south Puget Sound.

Current Stock Status of Groundfish in Puget Sound

Stock Status	Number of Stocks	Percent of Stocks
Critical	4	10
Depressed	7	18
Average	2	5
Above Average	9	22
Unknown	18	45
Total	40	

Although NMFS ultimately determined that no Puget Sound groundfish stocks warranted listing under the federal ESA, the Washington Fish and Wildlife Commission took a number of actions to protect depressed populations.

- Marine reserves:** Two new conservation areas, where no fishing is allowed, were established at Waketickeh Creek on Hood Canal and Saltar’s Point Beach in southern Puget Sound in February 2000 to serve as “natural hatcheries” for groundfish. A marine preserve, where only salmon trolling is allowed, was established at Colvos Passage near Gig Harbor at the same time. Together with six other marine reserves, these areas protect about 20% of the known rocky habitat of Hood Canal and 8% of Puget Sound’s rocky habitat from non-tribal fisheries. WDFW worked with local governments and area tribes to plan these reserves.
- Rockfish bag limit:** The Commission reduced the recreational bag limit for rockfish to one fish per day east of Slip Point in Clallam Bay, in response to these species’ depressed status. (The previous limit was five per day in northern Puget Sound and three per day in southern Puget Sound.) The new limit was expected to reduce the total rockfish harvest by 50%. However, the Commission also increased bag limits for black rockfish in the Sekiu area to allow fishers to take advantage of harvestable quantities of that species in the western portion of the Strait of Juan de Fuca.
- Spiny dogfish:** A new commercial harvest guideline of 500,000 pounds was established in 2000 for spiny dogfish, which showed precipitous declines in 1998 and 1999. The guideline applied to all three types of dogfish gear: trawl, set net and set line.
- Sixgill shark:** Until recently, sixgill sharks were rarely caught in Puget Sound. In the late 1990s, after they were spotted by scuba divers in Elliott Bay off Seattle, they became a popular fishery for anglers. Because so little is known about this species, WDFW closed the fishery by emergency order in 2000 and the Commission made the order permanent in May 2001. WDFW is participating in a joint research program with the University of Washington, Point Defiance

Zoo and Aquarium, and the Seattle Aquarium to collect data on sixgill shark populations.

- **Lingcod:** The Commission also reduced the period of time the lingcod season is open to scuba divers from six weeks to less than four weeks. This was designed to address a growing conflict with anglers, who were required to observe size limits while divers – who cannot measure a fish before they spear it – were not. Anglers are now allowed to fish during the first three weeks of the season, before the dive season for lingcod begins.

Forage Fish

Forage fish include a variety of small finfish that serve as a major source of food for other fish, seabirds and marine mammals. Several species – including herring, anchovy, sardines and smelt – are also caught in commercial, recreational and tribal fisheries.

Herring

Herring, traditionally fished primarily for their eggs, have long been the most important species of forage fish for Washington's commercial fisheries. In the 1970s, commercial landings of herring in Puget Sound and coastal waters reached as high as 14 million pounds per year.

Since 1984, however, state and tribal fisheries managers have reduced the allowable harvest to just a fraction of that amount to protect depressed herring stocks at Cherry Point and later at Discovery Bay. In 1999 through 2001, conservation measures adopted by the Washington Fish and Wildlife Commission and WDFW have restricted herring fisheries to just 600,000 pounds each year, primarily for use as bait for other species.

With the exception of Cherry Point and Discovery Bay stocks, herring in Puget Sound and coastal waters appear to be relatively abundant. Estimates of herring spawning biomass conducted by WDFW indicate that approximately 13,000 tons (26 million pounds) of herring spawned in state waters in 2000 and 17,000 tons (34 million pounds) spawned in 2001. These numbers are comparable with results obtained in earlier years, including 1999 when approximately 16,000 tons (32 million pounds) of herring spawned in Washington waters.



A male lingcod guards an egg mass in Puget Sound. Lingcod have long been popular with both anglers and dive fishers. – Wayne Palsson/WDFW

Sardines

Sardines are small, schooling fish that inhabit coastal waters from Mexico to British Columbia. At times, sardines have been the most abundant fish species in the California current, forming the basis for a large commercial fishery along the Pacific Coast in the 1930s and 1940s. The population collapsed in the late 1940s and – until recently – the last recorded Washington landings occurred in 1951.

That changed in May 2000, when the Fish and Wildlife Commission approved the first commercial sardine fishery in Washington in nearly 50 years. Surveys showed that the sardine population in coastal waters had been growing steadily throughout the 1990s, reaching 0.4 million metric tons (882 million pounds) in 1995 and rising to 1.6 million metric tons (3.5 billion pounds) in 1999.

In response to requests from Washington-based fishers and processors, the Fish and Wildlife Commission approved a trial ocean purse seine sardine fishery for the 2000 season. Anchovy, mackerel, and squid could also be landed. WDFW issued 45 permits and 11 permit holders participated in the fishery, harvesting an average of 50,000 pounds per set. A total of 10.8 million pounds of sardines were landed into Washington (including those caught off the Oregon coast) in 2000, followed by landings of 24.4 million pounds in 2001.

Condition of Puget Sound Herring Stocks

Stock Condition	No. of stocks in 1998	No. of stocks in 2000
Healthy	7	10
Moderately healthy	3	2
Depressed	5	3
Critical	2	2
Unknown	1	1

The abundance of sardine off the coast primarily depends on two factors: population size and water temperature. The larger the population size and warmer the ocean temperature, the more abundant sardines are during the summer months. However, if ocean temperatures remain cool, then the Washington abundance could be low even though the total population size is high.

Sardine abundance off Washington is variable and subject to considerable change annually, and adopting conservative management practices at this stage in the development in the fishery was considered a prudent approach.

Anchovies and Surf Smelt

Anchovies are a schooling species of forage fish, most common along the southern Washington coast. Little is known of their abundance or changes in abundance from year to year. Anchovies are caught primarily for use as bait in small commercial fisheries. In 1999, the commercial catch was 215,600 pounds, followed by a catch of 173,400 pounds in 2000.

Surf smelt are a popular sport fish, caught using long-handled nets as they come close to shore to spawn. During the 1999-01 Biennium, recreational fisheries caught an average of 110,000 pounds of smelt each year. Commercial fishers caught 215,000 pounds in 1999 and 173,400 pounds in 2000.

Columbia River Smelt

Adult Columbia River smelt (more properly called eulachon) are found throughout the lower Columbia River system during the winter months. Like salmon, smelt spawn in fresh water and the young fish move to saltwater, where they spend most of their lives. Typically, the adult fish spawn in the lower Columbia River and tributaries between January and March. The Cowlitz River is a major spawning location and

site of much of the recreational eulachon fishing in Washington state.

Run sizes remained relatively stable from 1938 through the early 1990s, when commercial landing averaged 2.1 million pounds per year. However, landings dropped suddenly in 1993 prompting severe commercial and recreational harvest restrictions by WDFW and the Columbia River Compact. In 1999 and 2000, the commercial harvest was held to just 20,900 pounds and 25,500 pounds, respectively. Recreational fisheries, once open year around, were restricted to 14 days in 1999 and 18 days in 2000.

In 2001, the spawning run increased considerably and may be a harbinger of larger stock sizes in the future. WDFW eased fishing restrictions somewhat, allowing commercial fishers to catch 177,000 pounds of eulachon in the Columbia River and 154,300 pounds in the Cowlitz River. Fishing time for recreational fishers was increased to 22 days.

During the course of the biennium, WDFW worked with the State of Oregon to produce the Washington and Oregon Eulachon Management Plan, the first of its kind for the species. The Department also joined in cooperative studies to investigate the genetic variability of eulachon, surveyed the abundance of larval eulachon and took steps to protect spawning habitat for the species.

Highly Migratory Species

While a number of highly migratory species are found off the Washington coast, albacore tuna is the primary focus of commercial and recreational fisheries in the state. Other landings include thresher shark, blue shark and swordfish. There is not a fixed season for albacore, but fisheries generally begin in early to mid-July and continue until the tuna are no longer accessible off Washington, usually around mid-October.

Total annual landings of albacore tuna have averaged more than 4 million pounds since 1980, fluctuating from year to year with market conditions. In 1999, commercial and recreational fishers landed 4.6 million pounds of albacore, followed by a catch of 7 million pounds in 2000. These variations are most likely an indication of changes in availability, rather

than fishing effort, since the number of vessels participating in the fishery has been consistent.

The ports of Westport and Ilwaco receive the majority of landings of highly migratory species, which are fished primarily by commercial trolling vessels, albacore bait-boats, and recreational charter boats. Washington does not allow the use of setnets, drift gillnets, and purse seine gear in the Pacific Ocean.

In 1986-88, the state conducted an experimental drift gillnet fishery for thresher shark, which resulted in disapproval of the use of such gear because of high incidental catch of protected species (e.g., marine mammals and sea turtles). However, there is a directed swordfish/thresher shark drift gillnet fishery operating out of California and Oregon. In December 2001, the Fish and Wildlife Commission approved the landing of highly migratory species caught in drift gillnets south of the Washington/Oregon border at Washington ports, subject to a ratio of one thresher shark for every two swordfish. The purpose of this ratio is to discourage the targeting of thresher sharks which were overfished in the late 1980s and are currently rebuilding, while allowing fishers to target swordfish which are more abundant.

The Pacific Fishery Management Council is in the process of developing a federal fishery management plan for highly migratory species, with final approval scheduled for November 2002. Management alternatives include a federal license requirement,

mandatory logbooks, and regulations to account for and reduce the amount of bycatch occurring in commercial and recreational fisheries for highly migratory species.

Unclassified Marine Fish

Washington's coastline is home to a wide variety of small marine fish and shellfish such as sculpins and sand dollars that are often visible in tidepools and other shallow areas in Puget Sound, coastal bays and the Pacific Ocean. Until recently, WDFW did not manage these species, because they have historically attracted little interest from commercial or recreational fishers.

However, recent studies by the state Department of Natural Resources have indicated that these species may be subject to intense localized harvest pressure, resulting in a substantial loss of biodiversity in those areas. In May 2000, the Commission adopted new recreational limits for these "unclassified" species, adopting recommendations made by a committee of WDFW staff and members of communities that collect and use these organisms. (See "Marine Education" in the Outreach section of this report for more information.)

The new regulation approved by the Fish and Wildlife Commission established a daily limit of two fish per species for any marine fish not already classified and managed as a "food fish." Recognizing that sculpin species are difficult to identify in the field, the regulation limits the harvest of sculpins to two per day, regardless of species.

Marine Fish Science

Reversing declining marine fish populations and habitat damage or loss will take time and a dedicated effort. Fish Program scientists have been pursuing numerous research and monitoring projects to ensure the efforts are based on sound decisions. These projects can be grouped into three general categories: abundance or stock status assessments, habitat evaluation and pollution studies.



The tiger rockfish is one of a dozen different rockfish species found in Puget Sound.

Abundance

A key component of any resource management effort is knowing the abundance of a given species and how it has changed over time. Scientists working for the WDFW Fish Program are involved in a number of studies to improve stock assessments.

- **Black rockfish tagging study:** In 1999 and 2000, Fish Program scientists continued a multi-year mark-recapture survey near Westport that began in 1998. Westport is the principal location of black rockfish landings on coastal Washington. Mark-recapture data will be used to produce estimates of abundance, survival, and mortality for these fish in the Westport area.
- **Cape Flattery lingcod tagging study:** Over the past 15 years, WDFW has conducted annual lingcod surveys at Cape Flattery using bottomfish troll gear. The survey, involving the use of coded-wire tags, produces survival and abundance estimates needed for assessing the stock status of lingcod in that area. The Department has adopted a new survey technique – direct catch sub-sampling – that should yield abundance assessments with greater precision than the previous method, which relied on voluntary tag returns.

- **Trans-boundary groundfish survey:** WDFW staff conducted a bottom trawl survey in the eastern portion of the Strait of Juan de Fuca, including both Washington and British Columbia waters, during the spring of 2000. Staff assessed groundfish abundance and distribution, and the ways in which oceanographic features affect abundance and distribution. Preliminary results showed a greater richness of species on the U.S. side of the boundary with 70 species found compared to 49 species found on the Canadian side. Complete results of the survey will be published in early 2002.
- **Trans-generational marking:** One of the crucial questions surrounding Marine Protected Areas (MPAs) is whether larval fishes hatched from adults in the MPA survive and migrate to areas outside the MPA. A marking program will allow researchers to better quantify how MPAs contribute to fish populations in harvest areas. However, because it is impractical to mark juvenile fish by conventional means, WDFW staff began a trial program in 2000 to induce a trans-generational mark by injecting strontium chloride solutions into female parents prior to larvae extrusion. Results have shown this technique to be successful and the agency plans to continue its efforts in this area.



The F/V Chasina from Port Townsend was contracted to trawl for WDFW's surveys and studies during the 1999-01 Biennium.

Habitat

Without abundant and appropriate habitat, it is unlikely that any long-term fish recovery will be successful. The key to knowing the health of marine fish habitat is an accurate understanding of the amount and status of available habitat and how that habitat provides the elements needed for marine fish survival. Agency scientists have been working on a broad spectrum of projects designed to give an accurate illustration of the status of marine fish habitat.

- **Evaluating no-take refuges:** In 2000, WDFW continued fieldwork evaluating the potential of no-take refuges as a fisheries management tool for re-

covery of Puget Sound rockfish and lingcod. Research has shown that rockfish and lingcod survive to a larger size in protected areas. Fish densities and the number of lingcod nests are also greater in the no-take refuges compared to corresponding fished sites. This information – along with stock assessments, fishery data, refuge comparisons, and video assessments of rockfish and lingcod populations and their habitat – will be used in developing a system of no-take refuges to help manage Puget Sound rockfish and lingcod.

- **Identifying forage fish spawning habitat:** Several species of forage fish use very specific types of intertidal or shallow water areas for spawning. Because it is not yet possible to replace spawning grounds for forage fish once they are rendered unusable by human activity, identifying and protecting these spawning areas is vital to forage fish conservation. WDFW received a grant from the Puget Sound Action Team to generate maps of all known spawning grounds of Pacific herring, sand lance, and surf smelt in Puget Sound. The maps are a popular and effective resource for local governments, land use planners, developers, and environmental groups.
- **Drifting algae/seagrass habitats:** Drifting algae and seagrass – which provide an important nursery and refuge ecosystem for many juvenile fishes – were studied for the first time in a collaborative research effort between WDFW, the University of Washington, and the Olympic Coast National Marine Sanctuary. This research has provided the first data on the composition and dynamics of drifting habitats, producing important biological and ecological information on many associated species of juvenile marine fishes and food organisms. It also made a significant contribution to the genetic database for rockfish. These findings will help determine the implications of policy decisions related to surface marine waters. The information will also be very helpful in making resource damage assessments after toxic spills and the subsequent clean-up efforts.

- **Mitigating impacts of overwater structures on eelgrass:** Habitat managers have long been concerned about the impact residential-type overwater structures such as docks, piers and floats have on eelgrass – an important habitat for many finfish, shellfish, and aquatic bird species. As part of a long-term research, WDFW worked to identify ways that these structures can be built without negatively affecting eelgrass habitat. Permit applicants were asked to use building materials that allow light to reach the water beneath their overwater structures, then monitor the eelgrass beds underneath for three years after construction was completed. Survey findings led the Department to recommend approval of structures that have grating, are north-south oriented, and that are, when possible, removed from the water for part of the year. This appears to provide for no net loss of eelgrass.

Pollution

Pollution can dramatically harm the marine environment, flowing from a variety of sources that are sometimes far removed from the marine environments it contaminates. Pollution mitigation is closely linked with stock recovery and habitat restoration efforts.

- **Puget Sound Ambient Monitoring Program:** This is a multi-agency effort to monitor the ecological health of Puget Sound. WDFW's role has been to measure contaminant levels in a variety of marine fish and salmon species located in both polluted and clean environments. WDFW measurements have shown English sole from urban and near-urban areas were between two and 33 times more likely to develop liver disease than fish from clean reference areas. Herring from central and southern Puget Sound had significantly higher PCB concentrations than herring from northern Puget Sound and the Strait of Georgia. Exposure to polycyclic aromatic hydrocarbons, which come from petroleum or the combustion of fossil fuels, was elevated in herring from central and southern Puget Sound, but not in fish from northern Puget Sound. ■

SHELLFISH

SHELLFISH AND OTHER MARINE invertebrates are part of a complex and highly productive marine ecosystem that includes crab, shrimp, clams, oysters, sea urchins, sea cucumbers and dozens of other species less well known. Many of these species support major commercial, recreational and tribal fisheries, which contribute millions of dollars to the state's economy every year. As individual species and as a group, shellfish also play a fundamental role in the ecology of the marine waters beyond the state's shorelines and are an integral part of the cultural heritage of the Pacific Northwest.

Commercial landings of shellfish, exclusive of recreational and tribal fisheries, commanded an ex-vessel price of \$77.3 million in the 1999-01 Biennium, more than any other fishery in the state. Recreational and tribal fisheries contributed millions more in economic benefits, helping to sustain many small communities, including those affected by cutbacks in the timber harvest and salmon fisheries. Record landings were reported in several fisheries during the biennium, reflecting a high abundance of some species and growing participation by recreational, commercial and tribal fishers.

As with salmon and steelhead, the state's shellfish harvest is shared in common with recognized treaty tribes in Washington, a treaty right affirmed in 1994 by a federal court ruling commonly known as the "Rafeedie decision." Since then, the Washington Department of Fish and Wildlife (WDFW) has worked closely with tribal fisheries managers to develop joint strategies for managing and harvesting this shared resource.

Working together, state and tribal co-managers completed 25 shellfish management plans in each year of the biennium. These management plans establish catch allocations, fishing seasons, harvest regulations and other measures designed to protect the resource and adhere to the legal parameters set forth in the Rafeedie decision.

Since the mid-1990s, fishing pressure has increased dramatically for several species of shellfish, notably Dungeness crab, shrimp and geoduck clams. In Puget Sound, the number of recreational crab and



Landings of Dungeness crab reached record levels during the 2000-01 season in several areas of Puget Sound.

shrimp fishers nearly doubled each year between 1999 and 2001, requiring significant reductions in fishing seasons to prevent exceeding annual harvest quotas. Dungeness crab fisheries in Puget Sound and elsewhere have also been caught in a squeeze of competition between commercial, recreational and tribal fishers in recent years. In the geoduck fishery, WDFW enforcement efforts uncovered a number of instances of "high-grading," night poaching and other illegal practices.

While catch statistics indicate that most shellfish stocks were in good health, concerns about reductions in fishing time, allocation issues, the market value of the commercial catch and the deficiency of scientific stock assessments on many species prompted several changes in shellfish management during the 1999-01 Biennium. In many cases, WDFW worked to carry out policies adopted by the state Legislature and the Washington Fish and Wildlife Commission; in others, the agency took action to address emerging situations on the fishing grounds. Major initiatives were adopted during the biennium for the following fisheries:

- **Puget Sound Dungeness crab:** The first annual harvest quotas were established for Hood Canal in 2000 and expanded to other areas of Puget Sound the following year. The Commission also established allocation guidelines for recreational and commercial fishers, and required

that all recreational landings be reported on a new catch record card, as directed by the state Legislature. Beginning with the 2001 season, recreational openings for all types of crab gear – not just pots – were based on WDFW’s assessment of crab shell condition.

- **Coastal Dungeness crab:** A limit of 500 pots was established for all commercial fishers during the 1999-00 season. For the following year, the Commission established a two-tiered limit based on historical landings, which restricted some license holders to 300 pots. This action was taken in response to legislation approved in 1994, which called on the Commission to work with the industry to establish an “even flow plan” to extend fishing seasons and maximize the market value of the catch.
- **Puget Sound shrimp:** Following up on legislation approved in 1999, the Commission took action to convert the commercial fishery in Puget Sound to limited entry status on Jan. 1, 2000 and made licenses transferable in 2001. The Commission also approved allocation guidelines for state recreational and commercial fisheries that establish harvest priorities for specific areas of the Sound.
- **Sea urchins and sea cucumbers:** In 1999, the Legislature authorized a commercial license buy-back program, funded through a surcharge on license fees and an increase in the landing tax on these species. Revenues generated by these taxes and fees grew throughout the biennium and the Fish and Wildlife Commission approved rules for the buy-back program in December 2001. WDFW is expected to announce the first round of buy-backs in 2002.
- **Unclassified marine invertebrates:** In May 2000, the Commission established bag limits for a variety of marine invertebrates (e.g. shore crabs, marine snails, limpets, sea slugs) not previously regulated by the state. The Commission’s action was based on observations of large declines in the diversity of these species in heavily harvested areas of Puget Sound.

State responsibility for shellfish management is shared by multiple agencies, including the departments of Fish and Wildlife, Natural Resources,

Puget Sound Crustacean Management Regions



Management areas shown here are referenced in this section of the report.

Health, and Parks and Recreation. These agencies worked collaboratively throughout the 1999-01 Biennium to conserve the resource, protect public health, offer predictable and stable harvest opportunities and provide easy access to information the public needs to enjoy these public resources. To help meet this last objective, WDFW established a toll-free shellfish regulation hotline (866-880-5431) and expanded its website (www.wa.gov/wdfw) to disseminate information about shellfish seasons and other related issues.

At WDFW, the Intergovernmental Resource Management Group took the lead in developing new harvest management policies for shellfish, working in conjunction with treaty tribes, the federal government and other states throughout the biennium. State management of these resources are the responsibility of the Marine Resources Unit, which also manages marine fin fish within the agency’s Fish Management Division. The total operating budget for the Marine Resources Unit during the 1999-01 Biennium was \$11.17 million, which includes state, federal and lo-

cal funds. The unit had a total of 96.7 FTE employees during the biennium, assigned to a variety of management and research responsibilities.

Dungeness Crab

Dungeness crab (*Cancer magister*) gets its common name from the town of Dungeness, Washington, on the north side of the Olympic Peninsula where it was first harvested commercially in the mid-19th century. The species ranges along the West Coast of North America, from the Aleutian Islands in Alaska to San Francisco Bay in California. Still the only commercially-important crab species in Washington, Dungeness crab is also harvested by a growing number of recreational and tribal fishers in Puget Sound and coastal waters.

The Dungeness crab population is highly cyclical rising and falling in conjunction with biological and environmental factors such as water temperature and the availability of food. On the coast, harvest levels spiked during the 1999-2000 season, then dropped to around the ten-year average in 2000-01. In Puget Sound, the trend was reversed, with significantly higher landings in the second year of the biennium than in the first.

Judging from creel studies and harvest records, Dungeness crab stocks appear to be robust, with a relatively high catch-per-unit-effort (CPUE) reported in most fisheries during the 1999-01 Biennium. WDFW conducted monthly field sampling to investigate the condition of crab in certain areas, but overall stock abundance is not assessed due to the ab-

sence of a valid methodology and funding constraints. Rather, Dungeness crab management has long been based on the premise that male crab of a minimum size (ranging from 5³/₄ inches to 6¹/₄ inches according to area) can be harvested so long as they are not in soft-shell condition.

As discussed below, WDFW implemented several new policies designed to protect the resource and allocate the catch during the 1999-01 Biennium, ranging from harvest quotas in Puget Sound to pot limits on the coast.

Puget Sound Crab

The 2000-01 season was a record year for Dungeness crab landings in several areas of Puget Sound. After an average annual harvest of 6.55 million pounds during the 1999-2000 season, total landings by all commercial and recreational gear types jumped to 8.23 million pounds, the largest recorded harvest in the history of the fishery. The estimated ex-vessel value of the commercial catch for those two seasons, including both tribal and non-tribal landings, was \$27.6 million.

One reason for the spike in crab landing was the cyclical nature of crab stocks. Another was the rapid growth in recreational and tribal fisheries over the previous five years, when twice as many crab were harvested as in the previous 15 years.

While Puget Sound crab stocks still appear healthy, mounting pressure on the resource and the need to meet allocation commitments prompted several changes in the management of crab fisheries during the 1999-01 Biennium.

- **Harvest quotas:** Pre-season harvest quotas were established and implemented in most areas of Puget Sound for the first time in 2001 to conserve the resource, meet harvest-sharing commitments with treaty tribes and improve management of seasonal fisheries. Under the approach developed by WDFW, quotas could be adjusted up or down, depending on an analysis of early season catch and catch per unit of effort. After a frenzied season marked by early closures in 2000-01, the new quotas were instrumental in providing a full recreational crab season in most areas the following year.



A crab pot is pulled aboard a commercial vessel in northern Puget Sound.

Puget Sound Dungeness Crab Harvest, 1995-2000

	1995	1996	1997	1998	1999	2000
REGION 1						
Recreational	380,600	249,700	400,700	436,400	376,300	369,807
Commercial	2,151,188	1,610,065	2,080,507	1,411,693	1,398,776	1,746,366
Tribal	1,938,594	2,046,074	2,202,260	1,901,733	1,868,911	2,215,925
Total	4,470,382	3,905,839	4,683,467	3,749,826	3,643,987	4,332,098
REGION 2						
Recreational	254,500	204,000	228,000	322,200	378,095	569,219
Commercial	519,525	400,021	384,166	391,063	605,395	512,727
Tribal	358,151	680,576	594,554	699,472	900,881	1,166,605
Total	1,132,176	1,284,597	1,206,720	1,412,735	1,884,371	2,248,551
REGION 3						
Recreational	50,200	80,500	105,300	70,800	62,600	96,221
Commercial	154,854	243,927	236,186	153,542	169,706	364,458
Tribal	4,340	76,176	294,842	220,722	219,650	406,679
Total	209,394	400,603	636,328	445,064	451,956	867,358
REGION 4						
Recreational	27,500	29,500	44,800	35,900	35,800	46,000
Commercial	0	0	0	0	0	0
Tribal	13,973	11,907	52,574	27,653	37,736	41,639
Total	41,473	41,407	97,374	63,553	73,536	87,639
REGION 5						
Recreational	320,000	281,700	280,100	248,600	246,600	345,308
Commercial	0	0	0	0	0	0
Tribal	45,647	140,253	247,846	317,919	250,700	352,717
Total	365,647	421,953	527,946	566,519	497,300	698,025
REGION 6						
Recreational	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Commercial	0	0	0	0	0	0
Tribal	0	0	154	0	82	838
Total	0	0	154	0	82	838
Grand Total	6,219,072	6,054,399	7,151,989	6,237,697	6,551,232	8,234,509

of gear can be just as damaging to soft-shelled crab as pots, WDFW closed fishing to all types of recreational gear during molting periods in 2000. The Commission adopted this policy by permanent rule in 2001. Shell condition also became the prime determination that year for opening recreational fisheries, which previously were pegged to fixed dates. Surveys conducted by WDFW in recent years show a significant variation in molting periods from area to area, requiring more precision in setting seasons. Once additional survey work is completed, WDFW biologists hope to determine cycles for each area of the

- **Allocation guidelines:** In February 2000, the Commission established general allocation guidelines for non-tribal commercial and recreational Dungeness crab fisheries in Puget Sound. The policy generally gives priority to commercial fisheries in north Puget Sound, while managing Dungeness crab in south Puget Sound and Hood Canal “for the exclusive benefit of the recreational fishery.”(See next page.) These management priorities were based on historical harvest patterns.
- **Shell condition:** Prior to the 2000 season, recreational crabbers were allowed to fish year around with all types of gear except crab pots in Puget Sound. Pots were prohibited when the crab were in soft-shell condition to prevent unnecessary injury and wastage. Responding to recent studies that show that star traps and other types

Sound to provide greater predictability in season openings.

- **Catch record cards:** Beginning in April 2000, recreational fishers were required to report their crab landings on a catch record card (CRC), which were already used for salmon, steelhead, sturgeon and halibut. WDFW added Dungeness crab to the CRC at the direction of the 1999 Legislature, which saw the need for more accurate estimates of the crab catch to ensure equitable allocation of the resource between state and tribal fisheries. Unlike the old field-based methods for estimating the catch, the CRC system can also produce estimates for each of the different gear types as well as for the various marine areas. Although compliance with the new reporting system was too low to use CRC data during the 2000 season, it improved sufficiently to allow

Crab allocation guidelines for regions of Puget Sound

In February 2000, the Washington Fish and Wildlife Commission established general allocation guidelines for allocating the crab harvest between non-tribal commercial and recreational crab fisheries in Puget Sound. Regional guidelines, based largely on historical fishing patterns, are cited below.

- **Region 1** – Provide for an economically viable and stable commercial harvest opportunity for high quality crab consistent with state/tribal allocation constraints. Maintain a quality recreational fishery with emphasis on spring and summer seasons and recreational exclusive use areas. Seek to provide reasonable recreational fishing opportunity to recover from impacts of the treaty summer fishery.
- **Region 2** – Provide for an economically viable and stable commercial harvest opportunity for high quality crab consistent with state/tribal allocation constraints. Maintain a quality recreational fishery with emphasis on spring and summer seasons and recreational exclusive use areas. Seek to provide reasonable recreational fishing opportunity to recover from impacts of the treaty summer fishery in the western portion of this region. The state fishery in Port Townsend Bay will be managed for the primary benefit of the recreational fishery.
- **Region 3** – Provide for an economically viable and stable commercial harvest opportunity for high quality crab consistent with state/tribal allocation constraints. Maintain a quality recreational fishery with emphasis on spring and summer seasons and recreational exclusive use areas. Seek to provide reasonable recreational fishing opportunity to recover from impacts of the treaty summer fishery. The state fisheries in Discovery Bay, Sequim Bay, Port Angeles Harbor; and Dungeness Bay will be managed for the primary benefit of the recreational fishery.
- **Regions 4, 5, and 6** – The state fishery in these areas will be managed for the exclusive benefit of the recreational fishery.

WDFW to use catch-card information for in-season management in 2001.

WDFW shellfish staff conducted a series of meetings with recreational fishers throughout the state in both years of the biennium to explain proposed policies, review seasons and determine local preferences for keeping harvest levels within prescribed quotas. In Hood Canal, for example, fishing was limited to four days per week during peak summer months in 2001 to provide for a longer season. Discussions with commercial fishers also led to agreement on a new requirement that all crab buoys be marked with a new identity tag to facilitate enforcement of pot limits. The Fish and Wildlife Commission approved the new buoy-tagging requirement in December 2001.

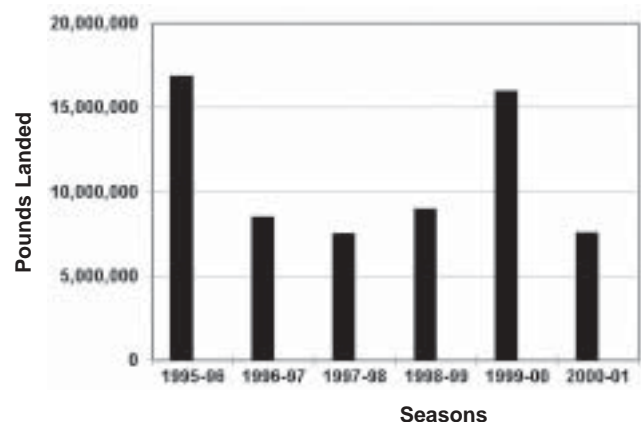
Pacific Coast Crab

Washington's coastal crab grounds extend from the Columbia River to Cape Flattery, near Neah Bay, and include Grays Harbor, Willapa Bay and the estuary of the Columbia River. While there is some recreational crab fishing on the coast, more than 99% of the catch was taken by 212 commercial vessels – both tribal and non-tribal – during the 1999-01 Biennium.

Total landings during the two-year period were 25.8 million pounds, reflecting a strong season in 1999-00 followed by an average catch the following year. The total ex-vessel value of the commercial catch for those two seasons, including both tribal and non-tribal landings, was \$50.1 million.

Crab landing data from the 1950s shows a large fluctuation in harvest, with landings ranging from a low

Washington State Coastal Dungeness Crab Harvest



of 2.5 million pounds in 1981 to a high of 21.8 million pounds in 1988. Biologists believe these fluctuations are related to water temperature, food availability and other ocean conditions.

The ex-vessel value of the commercial catch by both tribal and non-tribal fishers was \$32.6 million for the 1999-00 season and \$17.5 million for 2000-01, making a large impact on local economies. The commercial fishery is based out of the ports of Ilwaco, Chinook, Tokeland, Westport and La Push, where large seafood buying and processing facilities employ hundreds of people. The majority of the Dungeness crab fishery occurs during the winter and early spring months, long after summer tourists and sport fishers – and the dollars they generate – have left the region.

From the 1980s through the early 1990s the commercial fishery expanded to the point where half of the season's catch was being landed in the first three to four weeks of a nine-month season. In 1994, the Legislature approved a limited entry plan for the fishery and directed WDFW to work with fishers and processors to develop an "even flow plan," designed to extend the season and maximize the value of the catch.

Toward that end, the Washington Fish and Wildlife Commission approved a limit of 500 pots per vessel for the 1999-00 fishery, the first such limitation in the history of the fishery. In August 2000, the Commission adopted a "two-tiered" system, limiting license holders to either 500 pots or 300 pots depending upon historical landings.

As the biennium came to a close, WDFW staff continued to work with industry on development of a buoy tag program to strengthen the effectiveness of the pot limit. Staff also worked cooperatively with tribal co-managers and industry members to develop a harvest management plan for the 2002 summer fishery that will address potential molt of Dungeness crab before the season is closed in September.

Shrimp

Three types of shrimp are harvested in state waters by commercial, recreational and tribal fishers: pink shrimp, spot shrimp (prawns) and "sidestripe"



A WDFW biologist sorts shrimp during a study of bycatch in the fishery.

shrimp, which include a variety of species including dock shrimp (coonstripe shrimp) and humpback shrimp. All three types of shrimp are harvested in Puget Sound, and all except sidestripe shrimp are caught in commercial quantities in coastal fisheries.

During the 1999-01 Biennium, fishing pressure on shrimp varied significantly by area and by species. On the Pacific coast, a well-established commercial fleet of approximately 20 vessels landed 7 million pounds of pink shrimp and 250,000 pounds of spot shrimp during the two-year period – restrained, in part, by poor market conditions. In Puget Sound, however, competition between commercial, tribal and fast-growing recreational fisheries was so intense – primarily for spot shrimp – that WDFW fisheries managers estimate that any one of those groups could have taken each year's entire harvest quota by itself.

As with other shellfish, the shrimp harvest is co-managed by the state and treaty tribes, each le-

gally entitled to 50% of the harvest. Stocks in Puget Sound are managed on a regional basis, and appear to be healthy in all areas judging from harvest information. However, due to budget constraints, Hood Canal is the only area in Puget Sound or the coast where regular pre-season test fisheries are conducted to assess the relative abundance of spot shrimp and many areas are not surveyed at all.

As discussed below, continued growth in the Puget Sound shrimp fishery led to several policy changes in the 1999-01 Biennium, including a new limited-entry designation for the commercial fishery. WDFW, working together with the industry and treaty tribes, also helped to lay the groundwork for a "pots only" commercial fishery on the coast.

Puget Sound Shrimp

In 1995, the Fish and Wildlife Commission established regional quotas for all Puget Sound shrimp fisheries to protect the resource and to ensure an equitable allocation of the catch, as required under

the "Rafeedie decision." For the 1999-01 Biennium, WDFW and tribal fisheries managers developed 30 separate area harvest quotas each year: 17 for spot shrimp pot fisheries, six for non-spot pot fisheries and seven for trawl fisheries.

Recreational and tribal fishers mostly target the larger spot shrimp, while non-tribal commercial fishers use pot gear for spot shrimp and beam trawl gear for pink shrimp, also harvesting sidestripe shrimp with both kinds of gear. Non-tribal trawl quotas are restricted to non-spot species such as pink shrimp and coonstripe shrimp.

Fishing pressure on Puget Sound shrimp stocks has been building for a number of years. In 1977, commercial fishers severely depleted spot shrimp stocks in Hood Canal, resulting in a long period of recovery and the exclusion of the commercial fleet from the area. Since 1995, recreational fishers in Hood Canal have been restricted to one shrimp pot and seasons have been reduced dramatically to protect the resource and meet allocation requirements with treaty fisheries.

Puget Sound Shrimp Landings, 1996-2000

(Excluding Hood Canal) - Landings in pounds

	1996	1997	1998	1999	2000
Spot shrimp (pot fishery)					
Recreational	17,184	27,930	26,267	10,946	20,160
Commercial	41,173	60,024	60,755	50,701	56,705
Tribal	20,108	46,210	62,853	71,282	78,745
Non-spot shrimp (pot fishery) - (primarily Coonstripe)					
Recreational	2,124	3,452	5,922	3,776	4,653
Commercial	9,581	9,306	27,724	30,549	39,036
Tribal	0	0	5,503	0	314
Trawl Fishery - (primarily Pink)					
Commercial	651,848	678,455	707,292	648,965	683,931
Tribal	580,454	196,096	285,705	428,806	66,042

Elsewhere in Puget Sound, recreational fishing pressure nearly doubled each year from 1999 to 2001, prompting WDFW to substantially reduce fishing seasons to avoid exceeding area quotas. In 2001, recreational fishing time in central Puget Sound was reduced to four weeks at a time when fisheries in the San Juan Islands, the eastern Strait of Juan de Fuca and other inside waters also came under increasing pressure from growing recreational participation.

Hood Canal Spot Shrimp Fishery, 1995 - 2001

Year	TEST FISHERY	RECREATIONAL			TRIBAL	TOTAL
	(Pounds/pot) Catch rate	Catch	#Pots*	Lbs./Pots	(lbs) Catch	(lbs) Catch
1995	5.43	183,813	35,215	5.22	13,659	197,472
1996	5.76	100,005	24,709	4.05	102,584	202,589
1997	6.24	89,900	19,284	4.66	88,404	178,304
1998	5.01	75,541	18,969	3.98	80,543	156,084
1999	4.56	71,760	16,767	4.28	72,136	143,896
2000	4.8	77,010	18,071	4.26	77,941	154,951
2001	4.64	73,900	16,779	4.4	74,400	148,300

During the biennium, WDFW addressed these pressures through a variety of in-season management actions, including reducing the number of days open to fishing each week, pot limits, depth restrictions and (with the exception of Hood

Canal) new shrimp size limits. At the same time, the state Legislature and the Commission adopted two measures with long-term ramifications for the Puget Sound fishery.

- **Limited entry:** On January 1, 2000, the Puget Sound commercial fishery was converted to limited entry, as directed by the Legislature under SB 2107. Only those fishers who held a 1999 commercial license and who were eligible to fish under the Emerging Fisheries Act qualified for a limited entry license. The legislation provided for two types of licenses: pots and trawl. In 2001, the Legislature made licenses transferrable and approved a “pot-stacking” provision, which allowed fishers who hold more than one license to increase the number of pots they can fish. Industry representatives worked with the Legislature and the Commission to develop all of these measures, which were designed to help maintain the viability of the commercial fishery after years of increasing fishing pressure.
- **Allocation guidelines:** In February 2000, the Commission established general allocation guidelines for non-tribal commercial and recreational shrimp fisheries in Puget Sound. The guidelines, based largely on historical fishing patterns, vary significantly for each Crustacean Management Region in the state.

While these policies helped to stabilize the fishery, WDFW shellfish managers recognized that additional measures may be needed in the future to protect the resource and ensure an equitable allocation of the catch. To help achieve these goals, state and tribal biologists formed a joint technical group to develop new methods of estimating shrimp abundance, review biological assumptions and assess other factors used to develop harvest quotas. In addition, WDFW formed a Puget Sound shrimp advisory panel, with representation by both recreational and commercial interests, to discuss season structure, harvest allocations and co-management issues prior to the annual season-setting process.

Pacific Coast Shrimp

Coastal shrimp were fished almost exclusively by non-tribal commercial vessels during the 1999-01 Biennium, providing a relatively stable source of income for coastal communities from Westport to Ilwaco.

Shrimp allocation guidelines for regions of Puget Sound

In February 2000, the Washington Fish and Wildlife Commission established general allocation guidelines for allocating the shrimp harvest between non-tribal commercial and recreational shrimp fisheries in Puget Sound. Regional guidelines, based largely on historical fishing patterns, are cited below.

- **Region 1** – Provide for stable and economically viable commercial shrimp trawl and shrimp pot fisheries consistent with resource conservation goals. Maintain a quality recreational fishery through use of recreational exclusive use areas where needed.
- **Regions 2 and 4** – Provide for growth of the recreational and commercial coon stripe and pink shrimp pot fisheries consistent with conservation goals. Maintain a quality recreational fishery through the use of recreational exclusive use areas where needed. For spot shrimp the department’s management intent will be to approximate a 60/40 recreational/commercial split on an annual and long term basis.
- **Region 3** – Provide for stable economically viable commercial shrimp trawl and shrimp pot fisheries consistent with resource conservation goals. Maintain a quality recreational fishery through the use of recreational exclusive use areas where needed. The state fisheries in Port Angeles Harbor and Discovery Bay will be managed for the exclusive benefit of the recreational fishery.
- **Region 5** – The state fishery in Hood Canal will be managed for the exclusive benefit of the recreational fishery.
- **Region 6** – Provide for growth of the recreational and commercial coon stripe and pink shrimp pot fisheries consistent with conservation goals. Maintain a quality recreational fishery through the use of recreational exclusive use areas where needed. The spot shrimp resource in these regions will be managed for the benefit of both the commercial and recreational shrimp pot fisheries.

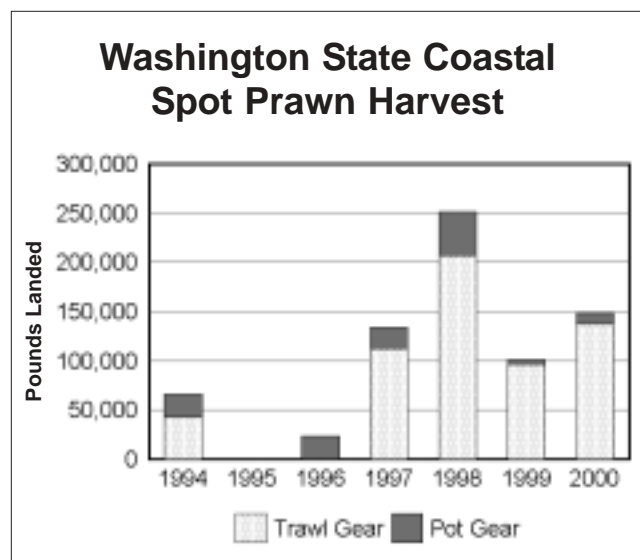
Pink shrimp makes up the bulk of the commercial harvest, although spot shrimp (prawns) has generated increasing interest by trawlers and pot fishers.

The pink shrimp fishery is well established, and is consistently open from April through October each year. The majority of the coastal Washington pink shrimp fleet is based in Westport, and delivers its catch to buyers and processors in Westport, Tokeland and Ilwaco.

During the 1999-01 Biennium, 22 active vessels landed approximately 7 million pounds of pink shrimp, with an ex-vessel value averaging 25 cents per pound. While this was a relatively poor price compared to previous years, fishers supplemented their earnings with the sale of groundfish caught incidentally to the shrimp.

Trawl landings for pink shrimp appear to be market driven, though they are also influenced by natural variations in production. Pink shrimp abundance off the coast of Washington is unknown but is assumed to be stable. Catch data is available but by itself is insufficient for assessing stock strength. Although there are no annual quotas on coastal pink shrimp, rules on trawl mesh size, season openings and allowable count-per pound are thought to provide adequate conservation protection for this species.

In contrast to pink shrimp, the commercial spot shrimp fishery is still a relatively new, developing industry. Started in the early 1990s by two Westport crabbers in search of a new fishing opportunity, the fishery has expanded to include not only pot gear but also trawlers.



Concern for the potential for over-harvest and over-capitalization of the fishery led the Department to designate the fishery as an experimental fishery under the Emerging Commercial Fishery Act in 1998. WDFW established an annual harvest quota of 250,000 pounds, and issued 15 permits based on historical catch criteria, as recommended by an industry panel of advisors. The majority of permit holders are Washington residents and most of these fishers live in coastal communities.

Fifteen vessels landed 101,000 pounds of spot shrimp in 1999 and 148,500 pounds in 2000. The highest value products are live shrimp that commanded an average ex-vessel price of \$8.00 per pound, while the average ex-vessel price for frozen "tail-only" shrimp was \$6.00 per pound. Spot shrimp (prawns) are sold in a variety of markets including dockside sales at Westport and Ilwaco and sales overseas, primarily to Japan.

The stock status of spot shrimp off the coast of Washington is unknown but assumed to be stable based on the fishery data information that has been generated. Due to the newness of the spot shrimp fishery and the concomitant lack of long term harvest data, stock assessment tools and models are still rudimentary.

The spot shrimp fishery takes place in waters beyond the state territorial sea and is evolving rapidly under the operational aspects of the Emerging Commercial Fishery Act. Due to concerns about the by-catch of other species by trawlers, WDFW worked with the coastal spot-shrimp industry during the second year of the biennium to develop a plan for converting trawl permits to pot permits. In December 2001, the Commission approved the conversion plan, which will phase out the use of trawl gear in the coastal spot shrimp fishery by Jan. 1, 2003.

Clams and Oysters

Washington's marine waters support a wide variety of shellfish, including clams and oysters. Habitat for shellfish abounds, with sandy ocean beaches, three major coastal estuaries and more than 2,300 miles of Puget Sound shoreline.

Major recreational, commercial and tribal fisheries harvest several clam and oyster species in three distinct habitats. On the coast, razor clams are abundant

in the 60 miles of sandy beaches, supporting a popular recreational fishery as well as a valuable tribal commercial fishery. Other intertidal clams, as well as oysters, are abundant along Puget Sound shorelines and are also found in the coastal bays. Giant geoduck clams are harvested on intertidal beaches and by commercial divers in subtidal habitats.

Recreational digging of intertidal clams and oysters is an extremely popular pastime in western Washington, generating more than 750,000 harvester trips during the biennium. Commercial harvest operations also contribute significantly to state and local economies. The ex-vessel value of the commercial geoduck harvest alone was more than \$30 million during the biennium, making it one of the most valuable shellfisheries on the west coast.

Intertidal clam and oyster fisheries on public lands are jointly managed by WDFW and western Washington treaty tribes under the "Rafeedie decision." WDFW's goals in managing the non-tribal portion of the harvest are to provide sustainable harvest opportunities while protecting the resource for future generations.

Razor Clams

Razor clams are the focus of a highly popular recreational fishery, drawing thousands of diggers to coastal beaches during scheduled openings. They also support tribal fisheries on the north coast and a small commercial fishery in Willapa Bay.

Washington's razor clams are found primarily on sandy beaches on the Pacific coast from the Columbia River to Kalaloch. WDFW conducts an annual coast-wide razor clam stock assessment during the late spring and summer months, with assistance from tribal governments whose members have fishing rights along portions of the coastline. Harvest quotas for upcoming recreational seasons are set based on the number of recruit clams (those over 3 inches in shell length).

Coast-wide razor clam stocks have remained relatively stable, averaging 13.3 million recruit clams for the past five annual surveys. The 1999 stock assessment produced an estimate of 13.1 million recruit clams with an average size of nearly 4.2 inches. The 2000 assessment generated an estimate of 14.9 million recruit clams with an average size of 4 inches.

Razor clam harvests are set and monitored within each of five management beaches: the Long Beach Peninsula, Twin Harbors between Willapa Bay and Grays Harbor, Copalis between Grays Harbor and the Copalis River, Mocrocks between the Copalis and Moclips rivers and Kalaloch within Olympic National Park. Fishery management plans are signed each year between WDFW and tribal governments with razor clam harvest rights.

Recreational razor clam seasons are set following a series of public meetings in the fall. These discussions allow WDFW to gather input from various stakeholders on season structure.

During the 2000 season, a total of 2.5 million clams were harvested by recreational diggers making an estimated 195,500 digger trips. Every management beach was open for harvest during portions of this period, except Kalaloch, which remained closed because of persistent high levels of the naturally occurring toxin, domoic acid.

During the 2001 season, an estimated 2.4 million clams were harvested in 178,100 digger trips. All five management beaches were opened at times during this season.

The positive economic impact generated by these razor clam fisheries makes a significant contribution to coastal economies. Razor clam diggers spend money in restaurants, motels, RV parks, gas stations and a variety of retail businesses.



Razor clam openings attract thousands of diggers to Washington's beaches, generating millions of dollars of revenue for coastal communities.

An analysis generated by the Grays Harbor County and Pacific County economic development councils estimated that the average digger spends \$25 per razor clam digging trip. Using the WDFW estimate of 371,400 digger trips made during the biennium, this equates to an economic benefit on the Washington coast of about \$4.6 million in spending by razor clam fishery participants each year.

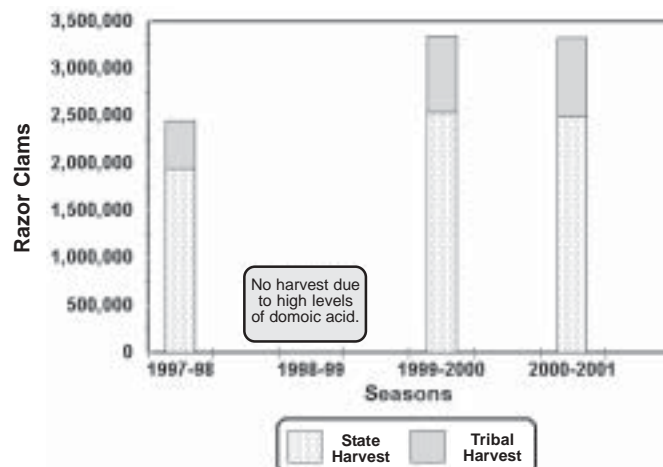
A commercial razor clam fishery has been conducted at the Willapa Spits since 1968, following the closure of ocean beaches to commercial harvest. Commercially harvested clams are sold primarily for crab bait, although those of good quality are also sold to the fresh market. The season is scheduled to open each spring after the recreational fishery ends, and generally runs six weeks pending acceptable toxin levels.

Approximately 90 harvesters participated in the commercial fishery each year of the 1999-01 Biennium, landing 130,000 pounds of clams with an ex-vessel price of \$1.00 per pound. Constant changes in the physical make-up and location of the spits and time and staff limitations preclude thorough assessment of stock abundance, which is assumed to mirror that of the coastal beaches.

Intertidal Clams and Oysters

Puget Sound is home to a variety of intertidal clam and oyster species, supporting recreational, commercial and tribal fisheries. Common species of clams found on intertidal beaches include Manila, butter, native little neck, horse, geoduck, eastern soft shell and cockles. Pacific and Olympia

Washington State Razor Clam Harvest



Intertidal Oyster and Clam Enhancement, 2001

Beaches Stock / Species	Quantity Planted	Sport Limit Equivalents
Pacific Oysters		
Birch Bay State Park	700 bags of seed	30,000
	90,000 harvest ready transplants	5,000
Bay View State Park	50 bags of seed	2,500
Freshwater Bay County Park	10,000 harvest ready transplants	2,222
North Penn Cove	60 bags of seed	3,000
Cline Spit County Park	110,000 harvest ready transplants	6,111
Sequim Bay State Park	190 bags of seed	9,500
	25,000 harvest ready transplants	1,389
North Sequim Bay State Park	120 bags of seed	6,000
Wolfe Property State Park	708 bags of seed	35,400
Illahee State Park	400 bags of seed	20,000
Potlatch State Park	1,200 bags of seed	60,000
Twanoh State Park	1,180 bags of seed	59,000
Penrose Point State Park	536 bags of seed	26,800
Frye Cove County Park	100 bags of seed	5,000
Tolmie State Park	40 bags of seed	2,000
Eagle Creek	65 bags of seed	3,250
Dewatto DNR 44A	62 bags of seed	3,100
Rendsland Creek	70 bags of seed	3,500
Manila Clams		
Freeland County Park	1,007,000 seed	6,293
Wolfe Property State Park	789,000 seed	4,931
Point Whitney	1,554,000 seed	9,713
Point Whitney Lagoon	1,160,000 seed	7,250
Shine Tidelands State Park	750,000 seed	4,688
Potlatch State Park	340,000 seed	2,125
Geoduck Clams		
Tolmie State Park	9,610 seed	2,563
Total		321,335

oysters are also found in varying degrees of abundance in Puget Sound. Coastal inlets, particularly Willapa Bay, support the same array of species, al-

though public access to the shoreline and the productive beds is relatively limited.

Most of the recreational clam and oyster harvest takes place on public tidelands in Puget Sound, encompassing more than 1,000 publicly owned beaches from Neah Bay through every basin of the Sound. The largest of these beaches are owned by several state agencies, including the Parks and Recreation Commission, the Department of Natural Resources and WDFW. Counties, cities and federal agencies also own beaches that are open for harvesting clams and oysters. Most commercial clam and oyster farming operations are located on private lands or on lands leased from the state, although WDFW operates a large oyster reserve in Willapa Bay that sells commercial harvest by auction.

While ownership is spread among a variety of organizations, WDFW and the tribal co-managers are the primary harvest managers of the inter-tidal clams and oysters. WDFW goals in managing the non-tribal portion of the harvest are to protect the resource while maximizing recreational harvesting opportunities for the general public.

In 2000, the recreational fishery harvested approximately 818,600 Pacific oysters and 187,000 pounds of "steamer clams," including both native littleneck clams and Manila clams. In 2001, the harvest of oysters declined by nearly 19% and the harvest of steamer clams dropped by 12%. This decrease in harvest occurred despite high numbers of oysters and additional steamer clam beds being certified for harvest. The primary factors that affected the harvest rates were:

- **Paralytic shellfish poisoning (PSP):** The widespread presence of PSP in many parts of Puget Sound significantly reduced harvest opportunities in 2001. The dramatic increase of this naturally occurring toxin, which is potentially harmful to shellfish consumers, reduced the number of harvest days by 30% during the second year of the biennium.
- **Clam bed recertification:** The recertification of several clam beds, combined with strong oyster populations, helped to offset recreational harvest reductions caused by PSP. The Duckabush River estuary on Hood Canal, previously off-limits to harvesting because of fecal contamination, was recertified in August 2001 after testing

Point Whitney Shellfish Hatchery

The Point Whitney Shellfish Hatchery, established on Hood Canal in 1974, is WDFW's only hatchery facility dedicated to shellfish production. The University of Washington also operates a shellfish hatchery in Manchester.

Since 1997, the Point Whitney facility has focused on the development of culture methodologies for native species of intertidal clams to provide the public with clams that are not produced commercially. In the 1999-01 Biennium, the hatchery produced Manila clams for the purpose of increasing harvest opportunities on key recreational beaches. In addition, the hatchery produced and planted more than four million Olympia oysters to restore this native species in Puget Sound and on the coast.

As part of WDFW's shellfish culture program, the Department maintains 70 artificial shellfish beds occupying 99 acres of tidelands throughout Puget Sound. During the 1999-01 Biennium, 21 beaches were stocked with 5,481 bags of Pacific oyster seed, 235,000 harvest-ready Pacific oysters, 5.6 million Manila clam seed, and 9,610 geoduck seed. This stocking was expected to produce the equivalent of 321,335 recreational sport limits.

showed the shellfish were again safe to eat. This cleared the way for harvests on an estimated 480,000 pounds of harvestable clams and 18 million harvestable oysters. The "new" clam quota from the Duckabush tidelands alone is nearly three-quarters of the combined quotas on all public beaches in Hood Canal.

Intertidal shellfish management occurs on a beach-by-beach basis, an approach that allows WDFW to maximize recreational harvest opportunities wherever funding is available to conduct direct resource and harvest assessments. When staff time is not available to perform direct assessments of the most heavily harvested beaches, WDFW and the tribes have a long-standing agreement to reduce the allowable harvest on those sites by 25% from the most recent survey data. While this management approach

reduces potential harvests, it offers resource protection on a precautionary basis when direct assessment information is not available.

Beach-by-beach management also allows WDFW to meet harvest allocation objectives by trading harvest quotas between beaches with tribal co-managers. For example, in 2001 the state traded a portion of its clam harvest quota to the tribes on a health-restricted portion of the Dosewallips River estuary, which is not accessible to non-tribal diggers. The tribes harvest the clams on the estuary and relay them to an area with clean water for a prescribed length of time so that they can purge contaminants before going to market. The tribes in turn gave the state a portion of its share of harvestable clams at Potlatch State Park, clearing the way for a larger recreational clam harvest on the popular beach.

As discussed later in this section, WDFW participated throughout the 1999-01 Biennium in a major research effort to determine the causes of marine toxin production in coastal waters and to develop an early warning system to alert resource managers when an outbreak is imminent.

Geoduck Clams

While some geoduck clams can be harvested by recreational diggers on beaches during extreme low tides, the vast majority of geoduck grow in subtidal Puget Sound habitats and are harvested commercially by divers. Access to this resource is nearly unique in Washington marine waters in that it is harvested

through an auction system, rather than an open-access fishery.

One of the most valuable shellfisheries on the West Coast, geoduck had an ex-vessel value of over \$30 million during the biennium. The non-tribal portion of the geoduck clam resource is co-managed by WDFW and the Washington Department of Natural Resources (DNR). State and tribal harvesters, who have equal shares of the annual harvest, took 4.2 million pounds in 1999 and 3.4 million pounds in 2000, with an ex-vessel value of \$16.4 million in 1999 and \$15.2 million in 2000. The majority of the clams are shipped by air freight to Asia, primarily China.

Subtidal harvesting occurs in water depths between 18-70 feet and is coordinated with treaty Indian tribes through annual harvest management plans in six Puget Sound management regions. Fishery managers have adopted an annual harvest rate of 2.7% of commercial stocks to maintain adequate populations of this valuable resource, and to provide a sustained yield for the future. Non-tribal commercial harvest opportunities are secured through a competitive bid process conducted by DNR, with revenues generated by the fishery, in part, funding the Aquatic Lands Enhancement Account and a resource management account.

A final supplemental environmental impact statement (SEIS) for the geoduck fishery was completed in May 2001, revising and updating a 1985 environmental impact statement. Results of the SEIS demonstrated a need for continued study of post-

harvest bed recovery, natural mortality, and age frequency distributions. Additional study is needed because of inaccuracies in catch reporting and geographical differences in growth, recruitment and natural mortality.

Water pollution continues to affect geoduck resources. In 1999, 47.7 million pounds of geoduck – more than one-fifth of the total biomass in the state – were off-limits to commercial harvesting because of contamination.

Recreational Clam and Oyster Harvest

	Year	Region 4*	Region 6**	Totals
Steamer clams	2000	42,200 lbs	144,500 lbs	186,700 lbs
	2001	60,200 lbs	103,000 lbs	163,200 lbs
Oysters	2000	50,000 oysters	795,000 oysters	818,590 oysters
	2001	23,600 oysters	665,000 oysters	688,600 oysters
Butter clams	2000	92,200 lbs	70,600 lbs	162,800 lbs
	2001	141,700 lbs	89,900 lbs	231,600 lbs
Cockles	2000	8,900 lbs	28,000 lbs	36,900 lbs
	2001	12,700 lbs	24,200 lbs	36,900 lbs
Razor clams	2000	--	2,588,300 clams	2,588,300 clams
	2001	--	2,476,300 clams	2,476,300 clams

* Region 4 includes northern Puget Sound, from southern King County to the U.S.-Canada border.

** Region 6 includes southern Puget Sound, the Strait of Juan de Fuca and the Pacific coast.

Compliance with fisheries regulations are sometimes difficult to ensure in geoduck fisheries. A 1999 investigation of the geoduck industry by the WDFW Special Investigations Unit documented more than 100 violations, including poaching, non-reporting and under-reporting of catch, harvesting in shallow water, off-tract harvesting, selling to unlicensed buyers and transporting clams in uncertified vehicles. The practice of discarding lower quality geoduck was found to be widespread. WDFW calculated the discard rate at one geoduck tract surveyed on Hood Canal at 28%.

A total of 50 felonies and gross misdemeanors were filed against one Canadian fish-buying company, and a number of other violations were turned over to tribal authorities. WDFW expects to file additional charges on at least four other companies in 2002 as a result of the two-year investigation.

Another result of the WDFW investigation was a strong commitment by harvest co-managers to improve monitoring efforts and make catch accounting an integral part of their state/tribal harvest management plans. As part of that commitment, the co-managers agreed to conduct post-harvest surveys on geoduck tracts to assess the condition of clam populations following a commercial harvest. The first post-harvest survey under this new initiative was conducted in 2001.

Sea Urchins and Sea Cucumbers

Commercial divers harvest sea urchins and sea cucumbers by hand throughout Puget Sound, primarily for sale to Asian markets. Initiated in 1971, the fishery is co-managed by WDFW and the treaty tribes, with non-tribal participation limited to those with a limited entry license.

During the 1999-01 Biennium, state and treaty tribal fishers landed 1.6 million pounds of sea urchins, with an ex-vessel value of \$1.4 million. During the same period, state and tribal fishers landed 1.1 million pounds of sea cucumbers, with an annual ex-vessel value of \$1.5 million.

A six-person advisory board, consisting of harvesters and buyers, makes recommendations to WDFW



WDFW biologists encounter a sea pen while conducting a geoduck clam survey in Puget Sound.

— Don Rothaus/WDFW

on harvest seasons and management issues. WDFW managers work closely with advisors throughout the harvest season to ensure accurate catch accounting and provide harvest opportunities to capitalize on dynamic market conditions.

Due to budget constraints, WDFW has not conducted stock assessment surveys for red sea urchins since 1995. As a conservation measure, Department and tribal shellfish managers agreed in 1998 on a 15% reduction in the annual total allowable catch (TAC) for red sea urchins, which remain in effect.

With the endorsement of the industry, the state Legislature approved a license reduction program (SB 5658) in 1999 to reduce the number of non-tribal participants in both fisheries. At that time, there were 47 sea urchin licenses and 50 sea cucumber licenses in fishers' possession, and the goal of the legislation was to reduce the number of licenses to 25 in each fishery. The program was funded by a surcharge on license fees and a tax on landing of sea urchins and sea cucumbers.

The Washington State Fish and Wildlife Commission approved rules for the buyback program in December 2001, allowing WDFW to schedule the first round of buy-backs in January of 2002.



State and tribal fishers landed 1.6 million pounds of sea urchins during the 1999-01 Biennium, with an ex-vessel value of \$1.4 million. – Don Rothaus/WDFW

Unclassified Shellfish

Washington's coastline is home to a wide variety of shellfish such as marine snails, shore crabs, limpets and sea stars that live in marine waters. They are often seen in shallow water and intertidal areas in Puget Sound, coastal bays and the Pacific Ocean. Until the 1999-01 Biennium, WDFW did not regulate the harvest of these species, because they have historically attracted little interest from recreational or commercial fishers. However, interest in harvesting of these species has grown immensely in recent years. As a result, significant declines have been observed in the number and diversity of these species on public beaches in Puget Sound, particularly in urban areas.

Acting on recommendations from WDFW staff and an agency-convened citizens' group, the Commission established a bag limit for all invertebrate species not classified as "shellfish" for management purposes. Effective May 1, 2000, an aggregate daily limit of ten organisms was imposed for all unclassified species. In addition, harvesters can collect two nudibranchs (aggregate all species) and five moon snails daily.

Shellfish Research

Shellfish support some of most important fisheries in Washington, contributing millions of dollars to the state's economy every year. Harvest pressure on crab,

shrimp and many other shellfish species is heavy, requiring WDFW and tribal fishery co-managers to make increasingly difficult decisions about when and how to best protect these valuable resources.

Unfortunately, scientific and biological information on many species is extremely limited. The very nature of the intertidal and subtidal environments that shellfish inhabit makes resource assessment, monitoring and management difficult. Funding limitations also require resource managers to make difficult choices about where to focus their research efforts.

Shellfish research in the 1999-01 Biennium was directed primarily at increasing baseline knowledge and understanding of the resource, improving management tools, developing and transferring technology, and protecting public health. Key research activities are summarized below.

- Marine bio-toxins:** In August 2000, WDFW initiated involvement in a major research effort designed to identify the mechanisms of toxin production and distribution throughout Washington's coastal marine resources. Olympic Regional Harmful Algal Bloom (ORHAB) is a federally funded, multi-agency partnership to investigate the origins of open-coast blooms of biotoxin-producing algae. One goal of the program was to establish an early warning system for biotoxin outbreaks to protect public health, especially during coastal razor clam fisheries. This system was tested in 2001, when a relatively small outbreak forced the closure of one of the state's five razor clam beaches. Early warning helped to reduce disruption to clam diggers and coastal businesses. Major partners in ORHAB include Northwest Fisheries Science Center, University of Washington School of Oceanography, University of Washington Olympic Natural Resource Center, Battelle Marine Laboratory, Pacific Shellfish Institute, Saigene Corporation, Quinault Indian Nation, and the Washington departments of Fish and Wildlife, Ecology and Health.
- Dungeness crab shell condition:** WDFW and tribal fishery co-managers continued field surveys in mid-1999 to better define the peak soft shell molting periods for Dungeness crab in Puget Sound. This action was in response to a conservation concern that crab fisheries were occurring during time periods when crab were soft shelled and mating, a very vulnerable phase

of their life cycle. The early focus of these studies was the San Juan Islands, Hood Canal and the Everett area where intensive recreational and commercial crab fisheries occur. In 2001, surveys of crab shell condition were initiated in the Strait of Juan de Fuca and Admiralty Inlet. Data from these field surveys showed that the crab molting period varies significantly from one area of Puget Sound to another and from year to year, complicating the crab season setting process. This research led to substantial changes in harvest periods, beginning in 2000.

- **Olympia oyster restoration:** Pilot studies were conducted in 2000-01 to investigate the potential for restoring stocks of the native Olympia oyster *Ostrea conchaphila* to certain areas in Puget Sound and Willapa Bay. Select beaches in Puget Sound and the Willapa Bay Oyster Reserve were planted with enhanced seed from local brood stock to establish study sites and create natural sanctuaries. Monitoring and other associated restoration activities will continue into the 2001-03 Biennium. Partners in the project include Puget Sound Restoration Fund, several treaty tribes, Washington Department of Natural Resources, federal agencies (NOAA and the U.S. Navy), private landowners and business interests, treaty tribes, commercial growers and young people.
- **Oyster aquaculture practices:** A joint study with researchers at the University of Washington and South Slough National Estuarine Research Reserve was designed to examine the influence of oyster aquaculture practices on estuarine habitat and biota including juvenile salmonids. Preliminary data in the four-year project, scheduled through 2004, suggest that some aquaculture practices such as oyster harvest operations negatively affect eelgrass. However, it was not clear how juvenile salmon utilize eelgrass or the oyster habitat that replaces it. Studies of juvenile salmon behavior and prey resources available in these habitats are under way.
- **Burrowing shrimp:** WDFW signed a memorandum of agreement with oyster growers and several other agencies in January 2001 to promote an integrated pest management (IPM) plan to deal with burrowing shrimp. As part of that

agreement, a research project was initiated to develop and test a monitoring program for burrowing shrimp that infest aquaculture beds and cause oysters to be smothered with mud and die.

- **Geoduck genetics:** Beginning in 1997, the WDFW Genetics Lab participated with researchers at the University of Washington in a three-year study of geoduck population genetics funded by Sea Grant. The goal of this project is to determine whether or not different genetic stocks of geoduck exist in Puget Sound and, if so, to define their geographic distribution. This information will be used to protect and manage the genetic diversity of this valuable resource. WDFW investigated protein (allozyme) markers and the University of Washington investigated DNA markers. ■



A WDFW technician sorts crabs, flatfish and other bottom-dwelling organisms during a Puget Sound trawl survey.

— Don Rothaus/WDFW